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Foundry Exhibition, 1955

The Engineering, Marine and Welding Exhibition and the Foundry Trades Exhibition is to be held at Olympia from September 1 to 15. The latter is one of a series which—except for the war years—has been held regularly since 1926. Whilst the Engineering and Marine Exhibition is held biennially, the Foundry Equipment and Supplies display—for that is in truth what it is—only takes place every four years. This section, for which space has been fully taken up, is not large, as there are only about 35 stands, but it is no worse for that, for thereby a visitor can examine everything. With a really large exhibition, it is only possible to adhere to a pre-arranged programme of visits, which usually leaves but little time for the exploration of the less familiar. Yet this whole exhibition (despite its very long name) is in fact an excellent foundry exhibition, for much space has been taken by many of the greatest engineering firms and here will be included multitudes of castings in service.

It is a debatable point as to whether an exhibition should be held concurrently with a technical congress. Theoretically they should be complementary, but it is sometimes found that one detracts from the other. The arranging of events in an extensive programme becomes involved, and perhaps both suffer. Yet for those from overseas, with a limited knowledge of the language of the country sponsoring such an event, time is sometimes better spent in an exhibition than at a technical session. Such indeed was the case in Italy. The timing of the International Congress, which is being held in London in June, and this exhibition in September, is spaced sufficiently for both events can be visited without inflicting undue inconvenience on one's normal business life. Important executives should visit both functions as, after all, the exhibition only needs one day in town, and results should be particularly rewarding.

From the standing of the exhibitors, we can assure readers, both home and overseas, that the exhibition in September will be of an outstanding character. The organizers, F. W. Bridges & Sons, Limited, Grand Buildings, Trafalgar Square, London, W.C.2, will supply free entrance tickets to any foundry arranging a group visit to London. For overseas visitors who indicate their desire to visit the exhibition, the organizers will arrange for their special reception and see that every facility is placed at their disposal. These are excellent opportunities for both executives and their staffs to familiarize themselves with the latest machines, processes and materials available to the foundry industry and complementary exhibits in the widest possible field of engineering.

Ventilation and Dust Control

BCIRA Conference at Harrogate, April 27 to 29

A conference on ventilation and dust control has been organized by the British Cast Iron Research Association to take place from Wednesday, April 27, to Friday, April 29, at Harrogate. It will be recalled that a previous conference was held on this subject in 1951 at Ashorne Hill. The present conference will consider advances and subsequent work in this field and will lay particular emphasis on measures to be taken to meet the new statutory regulations referring to dust and fume with which all foundries must comply as from January 1, 1956.

A provisional programme is given below. Visitors will be welcomed by the Association's president, Mr. S. H. Russell, and Sir George Barnett, HM Chief Inspector of Factories, has kindly agreed to give the opening paper at the first session on Wednesday afternoon, April 27. All the members of the BCIRA Foundry Atmospheres Team will be taking part in the conference and a number of external lecturers, experienced in problems of dust control and foundry ventilation, or concerned with the design of equipment, will also contribute papers. The headquarters of the conference will be at the Hotel Majestic, where all papers will be given.

Application forms should be completed and returned to the Association as early as possible, and not later than April 14, together with the conference fee of £1 10s. for each person attending.

Provisional Programme

Wednesday, April 27.

2.0 p.m.—Introductory remarks by the president of the BCIRA (Mr. S. H. Russell).

2.15 p.m.—"Health and Safety in the Foundry Industry," by Sir George Barnett (HM Chief Inspector of Factories); followed by "Dust Problems in Dressing and Fettling Shops," by Mr. W. H. White (BCIRA) (including short film); "Collection of Cupola Dust," by Mr. F. M. Shaw (BCIRA); and "Foundry Lighting Practice," by Mr. J. F. Roper (Electric Lamp Manufacturers' Association).

Thursday, April 28.

9.0 a.m.—"Reduction of Dust in the Production of Loose-pattern Moulds by the Application of Core-assembly Methods," by Mr. E. H. Beech (Metropolitan-Vickers Electrical Company, Limited); "Formation and Dispersal of Dust in the Foundry" and "Knock-out Ventilation," by Mr. W. D. Bamford (BCIRA). After luncheon: "Requirements for Efficient Dust-suppression of Foundry Knock-outs," by Mr. O. H. Jacobsen (Sturtevant Engineering Company, Limited) and Mr. A. W. Evans (Air Control Installations, Limited); and "Studies in Foundry Ventilation," by Mr. J. B. Dick and Mr. B. E. Collins (Building Research Station). After tea: "Ventilation Practice in American Foundries" (a paper submitted by American Air Filter Company, Inc., and read by Mr. R. M. Fyffe, of Air Control Installations, Limited); "A Test Survey of Air-purifying Equipment in French Foundries," from the *Centre Technique des Industries de la Fonderie*. After dinner: "Booth Ventilation for Swing-frame Grinders," by Mr. W. D. Bamford, and "Integral Exhaust System for Swing-frame Grinders," by Mr. C. M. Stoch (British Steel Castings Research Association).

(Continued at the foot of col. 2)

Friday, April 29.

9.0 a.m.—"Good Housekeeping in the Foundry," by Mr. E. R. Dunning (Midland Electric Manufacturing Company, Limited); "High-pressure Wet Cleaning and De-coring for the Smaller Foundry," by Mr. W. Russell (Pneulec, Limited) (including short film); Film, "De-coring and Cleaning Castings in One Operation by Shotblasting," produced by J. Bright and L. J. Stewardson, BCIRA, with the co-operation of Ruston & Hornsby, Limited (and discussion). After luncheon: "Low-volume, High-velocity Exhaust," by Mr. W. B. Lawrie, HM Inspector of Factories (Engineering and Chemical Branch); and, finally, "Summary and Conclusions," by Mr. C. Gresty (chairman, BCIRA Foundry Atmospheres Committee).

Tom Makemson Memorial

The Council of the Institute of British Foundrymen has approved a proposal to establish a memorial to the late Mr. Tom Makemson in commemoration of his 28 years' distinguished service as secretary of the Institute. After careful consideration of various suggestions, it has been decided that the memorial will take the form of an annual award of a Tom Makemson Bronze Medal and Prize to the best student, whether a member of the Institute or not, in the final patternmaking examination of the City and Guilds of London Institute. It is intended that the prize will provide for the purchase of tools by the successful candidate, and the medal and prize will be presented annually at a meeting of the Institute branch nearest to the winner's place of residence, if possible when the national president of the Institute is paying his annual visit to the branch.

A fund is to be established to found the award and all members and subscribing firms are invited to contribute. The Council is confident that the object of the appeal will warmly commend itself to all members, and to enable as many as possible to be associated with it, it is emphasized that all subscriptions, however small, will be welcomed. A receipt will be sent to each contributor but it is not intended to publish a list of subscribers. Members are requested to send their subscriptions as soon as possible to the secretary of the Institute, at St. John Street Chambers, Deansgate, Manchester.

Forty Years Ago

In the issue of the FOUNDRY TRADE JOURNAL for March, 1915, there is an illustrated article of a real *sand*-blast apparatus, wherein the operator is quite isolated from the dust by a current of air entering at ground level and leaving above his head. A sealed opening allows hand movement of the castings beneath the stream. It is a system worth examining even to-day. The April issue has another article which also could be usefully resurrected in view of the possibility of using a cupola to provide excess combustible gas. This article covers the subject of producer gas in the foundry and shows a multiplicity of uses ranging from mould drying *in situ* to ladle heating. A really extraordinary article, in view of modern developments, is one on oil-sand cores, the making of which seemed to present insuperable difficulties. An interesting item of news appearing is that Kryn and Lahy of Antwerp had acquired six acres of land at Letchworth for the purpose of erecting a new works. The formation of the Midland Motor Cylinder Company, Limited, is also noted. A note was printed in this issue about the cancellation of the technical part of the annual conference of the British Foundrymen's Association, owing to the war.

Defects in Steel Castings*

By R. A. Boustred

Any lecture dealing with defects in steel castings is of necessity controversial. Foundrymen, generally speaking, have very fixed ideas, and it is well known that the number of variables that exist in foundry practice are legion. Thus, similar defects are overcome in different ways in different foundries, and any agreement as to their actual cause may be difficult to obtain amongst a group of foundrymen with diverse experiences and background.

It is only in recent years that serious attempts have been made to put foundry practice on a scientific basis, but unlike purely theoretical problems that can be studied in the laboratory with the aid of test-tubes and microscopes, foundry problems are a combination of theory and practice. Thus, many theoretical solutions cunningly thought out in the laboratory or drawing office often give disappointing results in practice, where one is at the mercy of the skill of the moulder, the weather, the variation in the nature of the materials used, and more important, what the R.A.F. named "the gremlins." However, an attempt will be made to describe some of the factors which the Author considers to be important in the production of good steel castings.

It is appropriate at this stage to list some of the more common defects generally experienced in steel foundry practice. Many of them may be foreign to some of the more skilful members of the Institute, but it has been the Author's sorry plight to come in contact with them all, and it is almost with regret that he lists them as follows (typical defects being illustrated in Figs. 1 to 15):—(*a*) Blowholes; (*b*) pinholes and gas holes; (*c*) shrink; (*d*) scabs; (*e*) burning on; (*f*) hot-tearing; (*g*) non-metallic inclusions and "wash"; (*h*) cold lapping and short runs; (*i*) cracking; (*j*) heat-treatment defects; (*k*) cross jointing; and (*l*) crushing.

BLOWHOLES

Blowholes may be described as cavities, generally with smooth-walled surfaces, but sometimes appearing with jagged walls resembling shrink cavities. The latter appearance is caused by gas agitation just before solidification, and may also be the result of a combination of shrink and gas. This type is most common at sharp corners or areas where sharp changes in section thickness occur. The corner is an ideal "hot spot," and if not fed, a slight vacuum will be set up inside the casting. The metal skin will also be thin and weak; thus if the gas pressure outside the casting is high it may puncture the casting.

Blowholes only occur when the gas pressure in the mould material and mould cavity itself is greater than the metal pressure in the mould. Therefore, to prevent their occurrence one obviously needs to decrease the gas pressure or increase the metal pressure. Metal pressure may be increased by increasing the head metal, but this method is seldom used.

Theoretical factors affecting blowholes may be divided into:—(*a*) factors affecting the permeability of sand and (*b*) factors affecting generation of gas.

Factors Affecting the Permeability of Sand

(i) *Shape and size of sand grains:* A consideration of a packing diagram will indicate that spherical shapes will pack together with a higher percentage of voids than square or rectangular shapes. Thus sands with rounded grains are generally favoured. Furthermore, larger spheres will produce larger voids, and thus from a permeability angle alone larger grains are preferred to smaller grains.

(ii) *Distribution of sand grains:* Sands having grains of a uniform size have a higher permeability than sands having grains of mixed sizes. In the latter case the small grains may pack in between the voids formed by the larger grains and reduce permeability. Therefore the so-called "three-sieve sand" gained popularity amongst foundrymen, although the recent tendency has been away from this type due to expansion problems, which will be discussed later. The amount of clay and silt also affect permeability. However, there are many other factors besides permeability to be considered when choosing a moulding sand, and a balance has to be struck between conflicting ideals.

Factors Affecting Generation of Gas

Clay-bonded moulding sands contain water, and one volume of water expands to 1,668 volumes of steam at 100 deg. C. which further expands with increasing temperature. The lowest possible moisture content will therefore aid in the reduction of gas volume and gas pressure during the filling of the mould cavity with liquid metal.

Another important factor affecting the generation of gas is the type and amount of bonding agent or agents used. Natural clay and clays such as bentonite do not generate gas themselves; it is the combined moisture that may cause trouble. However, the oils, semi-solids and resins generate gas, and when using these binders large vents must be taken through cores and moulds to avoid possible "blows." It is advisable to ensure that all cores are thoroughly baked, so that most of the gas generated is eliminated in the drying stove. A sand with a high permeability is advantageous, not only for permitting freer escape of gas, but also for more rapid drying in the stove. There are, however, disadvantages with high permeability cores, as they burn faster than those with low permeability. Thus the release of gas in the mould is more rapid and blowholes are

* Paper read before the Institute of British Foundrymen, South African branch, and reprinted from *Engineer and Foundryman.*

sometimes found as a result, particularly in castings with thin sections.

Practical Causes

(*a*) Incorrect gating may cause metal turbulence or too rapid filling of the mould with the resultant trapping of gas or air, forming blowholes in the solidified metal.

(*b*) Proper venting over the mould cavity is generally essential. It allows the air in the mould and the gases produced during casting to escape freely.

(*c*) Cores are very often made with insufficient vents, as in most cases this is left to the discretion of the coremaker. Where possible, venting equipment should be supplied with the corebox to ensure correct venting. The sealing of vents from the mould cavity and the gumming of cores are also important, as many blowholes are caused by metal penetrating into the core vent, or gas generation from damp core-gum.

(*d*) The permeability of sand decreases rapidly with ramming and, therefore hard ramming must be avoided. In good practice mould hardness is kept to within close limits.

(*e*) Excessive sleeking or painting of the mould, which may close up the pores of the sand at the mould surface, should be avoided.

(*f*) Dry sand has the ability to absorb moisture, and if moulds are left open to the atmosphere too long the sand will "strike back." This striking back also reduces the strength of the sand, and in addition to possible blowholes, scabs may occur.

(*g*) As with dry-sand moulds, cores should not be stored for long periods or left in green-sand moulds. When closing, the core temperature should be the same as that of the mould, to avoid moisture condensation taking place.

(*h*) Blowholes are sometimes found with sand inclusions, indicating that the mould was not cleaned out before casting, and the moist dirt left in the mould has generated gas.

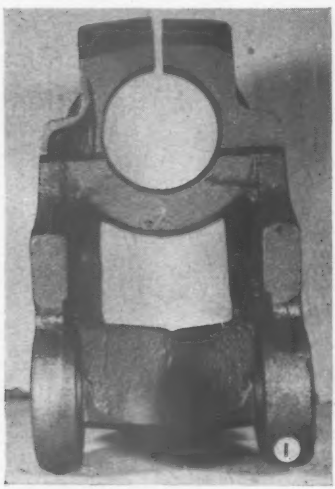
(*i*) Damp, rusty or dirty nails, chaplets, chills or denseners can generate gas when brought into contact with liquid metal. One method of treating chills is to heat them to above 100 deg. C. (which drives off all the possible moisture) and then to coat them with a material that will close up possible pores or cracks, preventing moisture re-entering the chill. Another method is to coat the chill with a material that will provide an avenue through which possible gas can escape rapidly into the sand.

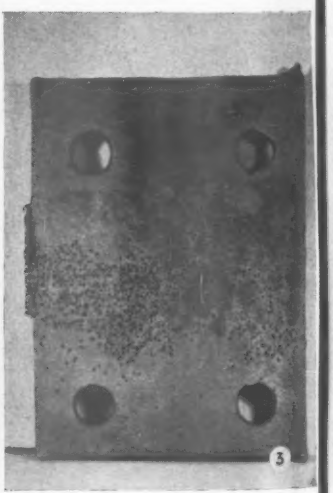
Pinholes

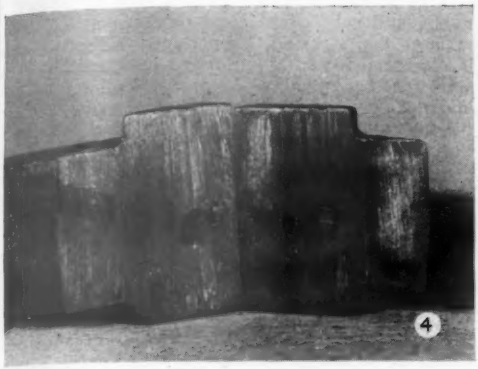
Pinholes may be described as tiny holes the size of a pinhead that may appear on the surface of a casting after removal from the mould, or appear only after annealing when the surface layer of scale has been removed. The defect may only be considered to be serious when occurring in small castings and when the surface appearance of the casting is important. The pinholes are generally shallow, and if they are present on a casting face that is to be machined, the defect will be removed during this operation.

The theoretical explanation of the formation of pinholes may be said to be somewhat obscure. Some foundrymen think that pinholes are started by bubbles of gas adjacent to the frozen skin, and that the bubbles grow simultaneously with, and in the direction of, the steel crystals in the surface

FIG. 1.—*Blowhole in a carbon-steel casting. (The casting was made in a green-sand mould and the blowhole was probably caused by the core absorbing moisture).* FIG. 2.—*Blowhole at an atmospheric riser (metal was blown out due to steam generated from a damp atmospheric core).* FIG. 3.—*An example of surface pinholes.*







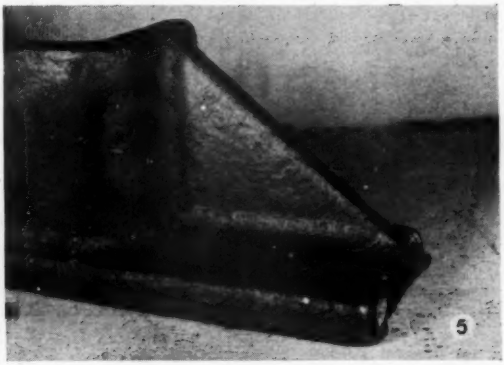


FIG. 4.—*Shrinkage defect in a carbon-steel casting (cavity caused through narrow riser ingate).*
FIG. 5.—*Carbon-steel casting in which the shrinkage cavity is seen at the junction of three sections. The defect would be removed by chilling or feeding the affected area.*

layer of the casting, by the diffusion of gas into the bubble from the surrounding solidifying and liquid steel—bubble growth continuing until the gas is depleted from the surrounding metal. The gas from the metal may be either hydrogen or carbon monoxide, and the solubility and formation of these gases in the liquid metal decrease with decreasing temperature, or in other words with solidification.

Formation

Factors affecting the formation of pinholes may be divided into (*a*) mould and (*b*) metal condition.

(*a*) *Condition of the Mould:* As in the case of blowholes, the presence of gas pressure at the mould surface will enhance the possibility of the formation of pinholes. What has already been said of factors affecting gas pressure when discussing blowholes applies equally well to pinholes. To recapitulate briefly, excessive moisture, low permeability, hard ramming and too rapid filling of the mould should be avoided.

(*b*) *Condition of the Metal:* Metal for steel foundries is most commonly melted either in an electric-arc furnace using a scrap-steel charge, or in a converter of the Bessemer or Tropenas type using a liquid cupola-metal charge.

The following points may be considered important in the promotion of hydrogen content in the steel made in the electric-arc furnace. Under the conditions of an electric arc, water dissociates into elemental hydrogen and oxygen, both of which are readily soluble in liquid steel. Thus, the use of damp or rusty scrap or damp slag-making materials must be avoided. However, hydrogen dissolved in the liquid metal during the melting down period may be removed during the oxidation period or "boil."

The main reaction occuring during this period is the oxidation or carbon by iron oxide according to the reaction:—

$$FeO + C \rightarrow Fe + CO.$$

The oxidation product of carbon is seen to be the gas, carbon monoxide, which is produced in large volume and which is not greatly soluble in the liquid metal. Thus numerous bubbles of carbon monoxide pass through the "bath" physically agitating it and absorbing molecules and bubbles of hydrogen to their surfaces and removing them. For this reason a vigorous "boil" is essential for both the acid- and basic-electric process, and a good steelmaker will always rely on boiling out 10 to 15 points of carbon after melting out.

Once the boil is complete and the steel has been "killed" the danger of hydrogen redissolving in the "bath" is great. Again it is necessary to avoid wet slag-making materials and alloy additions. High voltages, excessive bath temperatures, and long refining periods also promote the formation and solution of hydrogen. Converter metal does not present any great problems with regard to hydrogen gas.

Carbon monoxide

Unless a steel is thoroughly deoxidized or "fully killed," the reaction already mentioned:—

$$FeO + C \rightarrow Fe + CO$$

will occur during solidification, and give rise not only to pinholes and larger gasholes below and at the mould/metal interface, but also throughout the section of the casting. A steel that has only a small percentage of the strong deoxidizing elements such as aluminium and silicon which will reduce the FeO content, may be easily "upset" by damp ladles, green-sand moulds, and moist atmospheres, and is not favoured by foundrymen. The melting department can assist by supplying "fully killed" hydrogen-free metal at the correct temperature. Further consideration of the steelmaking problems in the foundry is outside the scope of this Paper.

Gasholes always appear in large numbers and are seen as smooth-walled cavities of all shapes and sizes throughout the casting. They are generally due to metal condition which has already been discussed under the heading "pinholes."

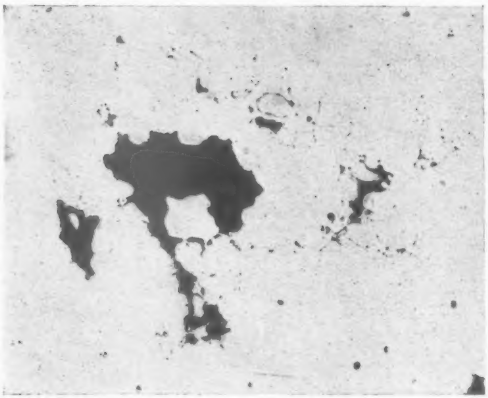


FIG. 6.—*Example of interdendritic shrinkage.*

SHRINKAGE

There are three types of shrinkage defects which occur in steel castings:—(*a*) Shrinkage seen as jagged-wall cavities in the heavy sections of the casting. (*b*) Shrinkage seen as micro-cavities, known as interdendritic shrinkage. This type is seen in even sections, and (*c*) Shrinkage appearing as a depression on the surface of the casting adjacent to the ingates of risers or in heavy sections.

TABLE I.—*Recommended Sizes for Atmospheric Risers and Knock-off Cores.*

Dia. of head (in.).	Height of head (in.).	Knock-off core; ingate aperture size (in.).	Knock-off core thickness (in.).	Atm., vent core size (in.).
3	5½	1½	¼	¼
3½	6½	1½	¼	¼
4	7	1½	¼	¼
4½	8	1½	¼	¼
5	9	2	¼	¼
5½	10	2½	¼	1
6	10½	2½	¼	1
6½	11½	2½	¼	1
7	12½	2½	¼	1
7½	13½	3	¼	1
8	14	3½	¼	1
8½	15	3½	¼	1½
9	16	3½	¼	1½
9½	17	3½	¼	1½
10	17½	4	¼	1½
10½	18½	4½	1	1½
11	19½	4½	1	1½
12	20½	4½	1	1½

During the cooling of steel from its molten state to ambient temperature, three separate volume changes occur:—(*a*) Reduction in volume during cooling in the molten state, which amounts to just over 1.5 per cent. for every 100 deg. C. of temperature change. (*b*) Reduction in volume during solidification which amounts to about 3.5 per cent. (*c*) Reduction in volume after solidification and subsequent cooling which amounts to about 7 per cent. The percentage of volume contraction in all cases depends on the composition of the steel.

Shrinkage defects occur when the foundryman has not made allowance for the volume change prior to, and during solidification.

Solidification of steel begins with the formation of nuclei and subsequent crystal growth as the steel reaches its freezing temperature. Thus, when liquid steel is poured into a mould, solidification starts at the mould walls, which chill the metal, and the crystals grow inwards in the direction of the hottest metal. So-called "directional solidification" is aimed at, so that the last metal to solidify is the feed metal. Should this ideal be attained, castings free from shrinkage defects will result. The speed and direction of solidification depend on the thermal gradients throughout the mould, which the foundryman can in most cases apply methods of control.

Directional Solidification

Factors affecting directional solidification may be listed as: Casting design; running and risering; chills; teeming.

Casting Design: Casting design is the most important factor in the production of homogeneous castings, and poor design leads not only to high production costs but sometimes to insoluble "feed" problems. Consequently, close co-operation between designer and foundryman is essential.

Running

Running techniques may be discussed under four main headings. Top runners, bottom runners, parting or joint-line runners and step runners.

Top runners: Top running is generally used only when the casting is of simple design, as this type of runner may cause excessive erosion, particularly if the metal be allowed to impinge on cores or projecting areas of the mould. The best results are obtained when a number of ingates are used instead of one common ingate. The advantage of this type of runner is that it is possible to obtain directional solidification from the bottom upwards.

Bottom runners: This is probably the most popular type of runner, although it is by no means ideal for directional solidification. It has the advantage of allowing minimum turbulence in the mould and free escape of gas. It is easy to position the ingates so that the metal does not impinge on cores or mould projections. The velocity of the metal entering the mould can be reduced by the use of "choke blocks," or changes in direction of flow. When using this type of runner it is obvious that the hottest metal is at the bottom, and directional solidification must be obtained by tapering the wall sections from the top, splitting the casting into two separate feeding zones by the use of atmospheric risers, reversing the mould after teeming, or lastly, by topping up the risers before the mould is completely full.

Parting or joint-line runners: These are probably the most common type as they are the cheapest. It is easy to cut or mount runners on the joint-line. When using this type of runner, it is important to control the areas of the ingates in relation to that of the sprue bar and downgate.

The total area of the ingates at the point where they cut the sprue bar should be the same as the

tal cross-sectional area of the sprue bar, so that ll ingates operate. The cross-sectional area of the owngate should be greater than the sprue bar to nsure complete filling of the latter.

The runner is frequently used in conjunction with hirl risers, and generaly speaking it is easy to ontrol directional solidification by sensible posi- oning of the risers. If whirl risers are not being sed, the ingates are placed as near as possible to he risers.

Step runners: This type of runner is a combina- ion of all three mentioned. In principle, the first netal enters the mould at the bottom and fills pro- ressively through ingates positioned at different evels up the mould walls, the last metal entering he mould at the top. This type of runner is diffi- ult to design, but, if correct, is ideal for obtain- ng directional solidification and minimum mould rosion.

Risering

Two factors must be carefully considered when esigning the risers or feed metal for a casting. hese are "size" and "position." Feed metal nust be supplied to a solidifying casting, at the ight time, in the correct place, and in sufficient uantity. Two types of risers are used: "open" nd "blind."

"Open" risers are those that have their upper- most surface open to the atmosphere. When using his type it is advisable to apply an insulating naterial at the air/metal interface, to prevent reezing over, as the effect of atmospheric pressure s lost when this occurs. The advantage of an pen riser is that it is possible to add feed metal to after completion of pouring, and also during ubsequent solidification. These risers can be used n conjunction with exothermic sleeves, when igher yield values can be obtained.

"Blind" risers are those that are surrounded by he mould material. They must be used in conjunc- ion with atmospheric pressure. This is obtained y creating a localized hot-spot in the uppermost area of the riser, which enables atmospheric pressure to puncture the skin of solidified steel that forms on filling the riser. This hot-spot is obtained by inserting a small core or graphite rod in the riser. The insertion of a graphite rod lowers the freezing temperature of the steel adjacent to the rod, as carbon is absorbed by the steel.

A given mass of metal in a "blind" riser will remain liquid for a longer period than in an open riser, as there is less dissipation of heat. Other advantages of "blind" risers are that they permit bottom running through a riser, and they feed sections greater than their own height. Theoretically they should feed a casting section to a height slightly greater than 4 ft. above the riser, *i.e.*, a ferro-static head equivalent to one atmosphere.

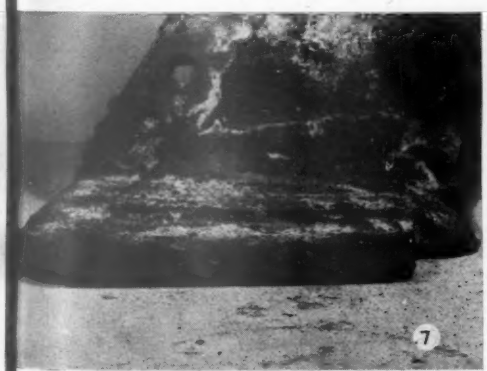
The efficiency of the riser is affected by (*a*) shape —spherical shapes, followed by cylindrical shapes, have the least surface area, thus risers designed to these shapes are the most effective; (*b*) size—the size of a riser depends on the size of the area to be fed. It is difficult to calculate riser size theoretically as many variables must be taken into account. For example, the riser size required will be affected by the surface area of the section to be fed, and by adjacent sections being fed by the section to which the riser has been attached.

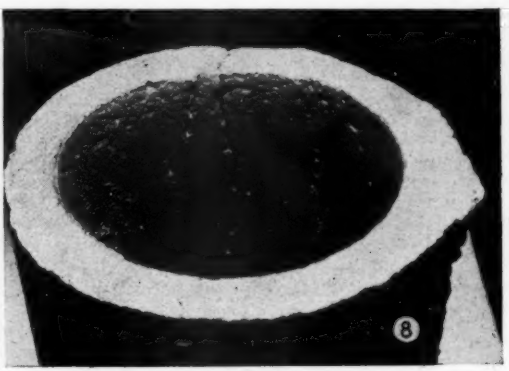
Several formulæ have been devised, but they generally apply only to particular types of castings such as plates, bar or rods, or only to particular sections such as T, L, or Y sections. The foundryman's own knowledge and experience is the only sound criterion. It is important to keep the height of the riser in relation to the diameter, and the recommended height is 1½—2 times the diameter.

The riser ingate size should not be smaller than the section to be fed; it is just as important as in the case of the riser to keep the neck fluid for a longer period than the casting. It is advisable to pad the neck well into the riser.

The use of "knock-off cores" is becoming increasingly popular. However, when using "knock-off cores" the aperture size of the ingate and the

FIG. 7.—*Burn-on of sand to a manganese-steel casting, due to too-high a casting temperature.*
FIG. 8.—*Hot-tear of a stainless-steel casting, caused by core of too-high a hot-strength.*





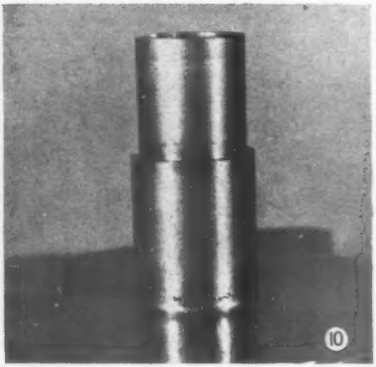


FIG. 9.—*Hot-tear in a carbon-steel casting, the result of excessive flash at the top of the riser.*

FIG. 10.—*Hot-tear of a stainless-steel casting caused by poor casting method. The riser attached to the boss restricted contraction; when the riser was moved to the front of the impeller and the casting made the other way up, the defect was removed.*

thickness of the core must be controlled. It is also advisable, particularly when using small risers, to run the casting through the "knock-off core" so that the core has an opportunity of heating up.

When positioning risers it is important to ensure that separate feeding systems are established during solidification. It may often occur that due to poor design one riser feeds not only the casting but also another riser.

Chilling

Chills and denseners are used to direct the solidification in the casting, or to ensure soundness in areas that cannot be conveniently fed. Chills must be correctly positioned if they are to be effective. For example, chills positioned near to runners or in the direction of flow of the metal lose their effectiveness because of preheating. The positioning of chills near risers is bad practice, because the area near the risers ingate may solidify early and cut off the supply of feed metal from the riser.

Teeming

High teeming-temperature, generally speaking, must be avoided. Often the direction of solidification can be reversed due to over-heating of the sand mould, and it is obvious that the greater the amount of heat energy to be extracted from a casting/mould system, the more difficult will be the control of its dissipation. Fast teeming can establish even temperature gradients throughout the mould, which is advantageous for certain types of castings.

BURN-ON

Burn-on or metal penetration of the sand occurs as a surface layer on the casting of intermixed steel and sand particles, and owing to its tenacious and highly abrasive nature, it is very difficult to remove economically. It may be caused by simple penetration of liquid metal into the mould surface, or by chemical reaction between the steel and the mould sand or mould paint. For example, austenitic manganese steel of the Hadfield type containing up to 14 per cent manganese reacts with silica according to the following reaction:—

$Mn + SiO_2$ (silica) $\rightarrow MnO_2 + Si$ (silicon) and other more complex compounds.

Similarly, low-carbon steels are more prone to oxidation and the formation of iron oxide from iron silicates when in contact with moulding sands.

At one time, the answer to burn-on was thought to be highly refractory sands. In recent years however, many authorities have advocated the use of moulding sands which give rise to liquid mould/metal reaction products at the mould wall, thus preventing metal penetration. The highly refractory sands are therefore becoming less popular. Certain mould-washes containing iron oxide or lime may also be used to give rise to a liquid surface film.

A further example of this is the addition of sodium carbonate to moulding sands advocated by certain foundrymen to decrease the hydrogen ion content, and thus improve bonding properties of bentonite clay. In certain other foundries, however, sands high in alkali are discarded as unsatisfactory, because of their lower melting point.

Metal Penetration

Simple metal penetration is a function of the sand, ramming and running technique, and casting temperature.

(*a*) *Sand:*—

Coarse-grained sands obviously provide the more permeable mould surface and therefore give rise to burn-on. Methods of closing up sand pores may be adopted, such as the addition of silica-flour or fireclay, but these are at the expense of permeability and are only advocated for dry-sand moulds. Pelleted pitch may also be used, as this may provide a viscous mould surface at temperature.

(*b*) *Ramming:*—

Soft ramming will provide a permeable mould surface and therefore should be avoided.

(*c*) *Running Technique:*—

Running methods that allow a considerable amount of metal to pass over a particular area will promote the possibility of metal penetration.

(*d*) *Casting Temperature:*—

High casting temperature should be avoided, as it results in greater fluidity and slower solid-skin formation at the mould walls.

HOT-TEARS

Hot-tears are irregular jagged discontinuities that appear both on the surface and within the metal

section of a casting. They are referred to as external and internal hot-tears respectively. The internal type are the more dangerous as their occurrence is revealed only by X-ray, or radiographic methods, or during machining operations, and in some cases only after failure in service.

Hot-tears are caused by contraction stresses. There is some disagreement as to when they actually occur. The latest information states that they are most likely to occur during the late solidification period, when there is only a thin film of liquid steel beween the solidified crystals. During this stage the section may tear when under a stress of only a few pounds per sq. in. (below 20 lb. per sq. in.). Tearing may also occur after complete solidification, if the stresses set up are greater than the strength of the solidified section.

Contraction stresses are inevitable, but generally only give rise to hot-tearing when casting and/or mould and core design are at fault.

Casting Design

The following points should be considered of importance when studying casting design.

(1) Hot-tears usually occur at the sections of castings which solidify last and isolated hot-spots should be avoided.

(2) Thin sections freeze and contract faster than thick sections; it is obvious therefore that varying thicknesses or sharp changes in sections will promote contraction stresses.

(3) A section that is prone to hot tearing should never be thickened but always reduced. Increasing a section enlarges the hot-spot; enhancing the possibility of tearing.

(4) Corners and interleading sections should be streamlined.

(5) Where possible, areas where vertical sections join parallel sections should always be ribbed. The thickness of the ribs must be in relation to the thickness of the section, as the ribs must solidify before the sections, if they are to be of any service to the hot-tear problem.

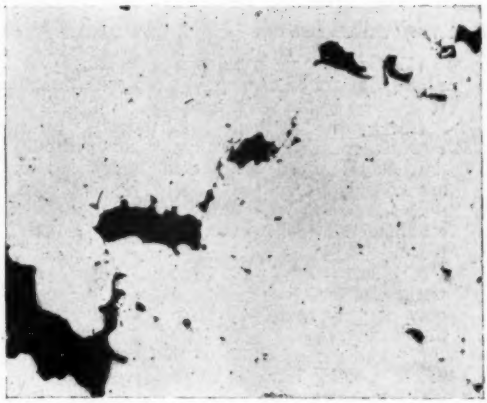


FIG. 11.—*Example of an internal hot-tear.*

(6) The principle of directional solidification should be applied to all designs. In many cases, shrink cavities initiate hot-tears, as the strength of the section is reduced by the presence of shrink.

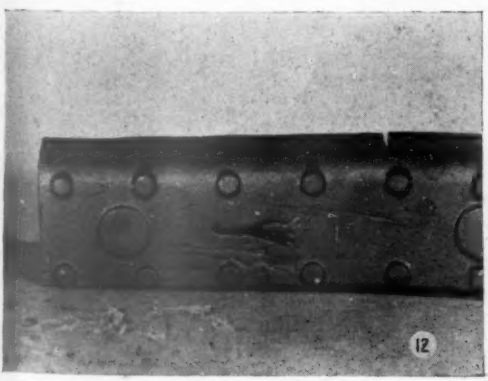
Mould and Core

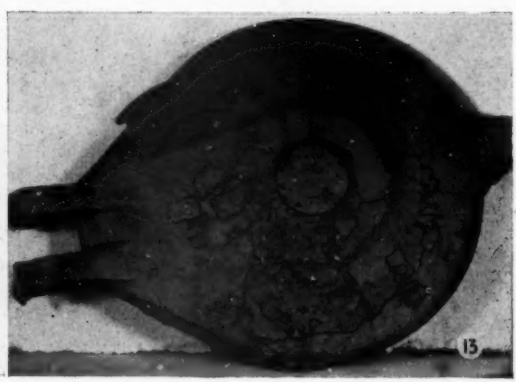
The occurrence of hot-tears due to the mould or cores is a function of the materials used. They may be considered as follow:—

(1) It has been found that sand mixes having a high hot strength are more prone to cause tearing than those of low hot-strength. High hot-strength sands are those having a high percentage of the materials such as zircon flour, silica flour or fireclay.

(2) Rapid collapsibility, giving low hot-strength, can be induced by additions of cereal binders or materials such as sawdust.

FIG. 12.—*Hot-tear and cold-shut defects in a heat-resisting casting. The casting was made in a shell mould and both defects were caused by too-low a casting temperature. The hot-tear occurred due to insufficient mould breakdown.* FIG. 13.—*Scabbing on a carbon-steel casting.*





Defects in Steel Castings

(3) Green-sand moulds are obviously less prone to promote tearing than dry-sand moulds, if rammed to the same density.

(4) Organic binders are thought to be advantageous, since they break down rapidly, particularly when castings of heavy sections are considered.

(5) Excessive ramming resulting in high mould density will prevent contraction taking place.

(6) Core irons or moulding-box bars positioned too close to the surface of the mould may possibly result in restricted contraction of the casting.

(7) The use of chills at the particular area where tearing is occurring may remove the tear. However, in most cases the hot-tear recurs in another area, and it may be advisable to permit tearing in an area which is easy to weld.

(8) Incorrect running may cause localized hot-spots, or incorrect sprue bar positioning may affect the contraction of the casting.

(9) Rapid knocking-out, or digging out of sand around downgates or risers may prove advantageous.

Metal Composition

Low casting-temperature favours low temperature-gradients, resulting in more uniform solidification rates, and rapid formation of a solid skin—permitting greater resistance to contraction stresses. It has the disadvantage, however, of inducing higher solidification rates, resulting in more rapid stress-development.

High casting-temperatures on the other hand produce higher temperature-gradients and thinner solid-skin formation, but give longer rates of solidification which allow longer time for the occurrence of mould breakdown.

Metal composition may also give rise to hot-tearing. For example, high-sulphur percentages unbalanced by manganese, promote the formation of iron sulphide which has a melting point well below that of steel. Thus interdendritic segregation of this constituent weakens the solidified metal matrix and hot-tears result. In general, elements and compositions which promote the formation of low-melting-eutectic phases promote hot-tearing.

SCABS

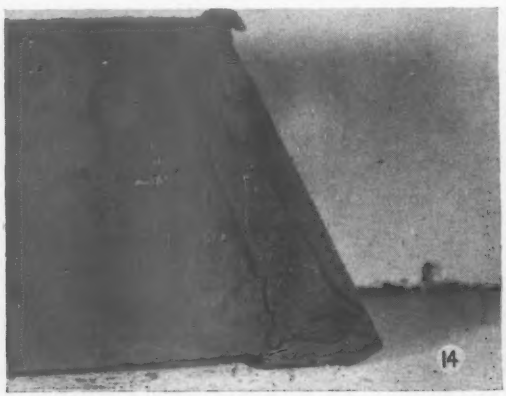
There are two types of scab defects which occur in steel castings. First, the scab which appears on the surface of the casting as a raised area with an extremely rough surface. It is not normally dangerous in itself as the affected area can easily be ground off. However, the scab is formed when an area of sand is dislodged from the mould wall, and this sand is invariably lodged in some section of the casting, with the result that rectification is impossible.

This dislodgement may be due to the following causes:—

(*a*) Excessive gas pressure in the mould material that may force weak areas of sand into the mould cavity. The weak areas of sand are caused by uneven ramming, ramming too close to the pattern, poor patching of the mould, etc. Therefore, factors promoting gas pressure, discussed in the formation of blowholes, should be avoided.

(*b*) Sands of too-low strength, resulting from insufficient bonding agents or improper milling, will give rise to scabbing, as will sands of too-high strength. There is a certain toughness range for each particular sand mix. Below the minimum range, scabs may result from excessive erosion. Above the range, they may result from sand embrittlement, because sand becomes more brittle as the hot-strength increases.

FIG. 14.—*"Blind" or expansion-type scab on an alloy-iron casting made in "green" sand.*
FIG. 15.—*"Blind" or expansion-type scab on a heat-resisting steel casting made in "green" sand.*



(c) Turbulent metal flow or metal impingement on weak sand projections in the mould, may easily dislodge an area of sand.

The expansion scab, referred to as a blind scab or buckle, is seen as a rough surface layer of metal partly separated from the casting by a thin layer of sand. It is caused by sand expansion. During the filling of a mould with liquid metal, heat is radiated on to the mould wall. Sand is a poor conductor of heat, thus a thin surface layer of sand reaches a high temperature in a relatively short time. It is well known that silica expands on heating, and very rapidly between 500 and 600 deg. C. The alpha to beta phase change of silica occurring at 575 deg. C. is accompanied by expansion. If the sand is of low plasticity, this rapid expansion will cause it to crack or buckle into the mould cavity. The metal on reaching this area will flow through the crack into the void behind and form a blind scab.

Expansion of Sand

Sands of large grain size are to be preferred to the reverse since their expansion is less rapid. Furthermore, grain distribution is an important factor, as uniform grain-size results in simultaneous expansion, whilst mixed grain-size will give a more varied expansion. The permeability is also important, as it affects the dissipation of heat. The higher the permeability, the faster the heat dissipation, and the less the tendency for sand to scab. It is possible to control the expansion rate of a sand moulding mixture by the use of the different types of binders, or by adding materials such as pitch or sawdust. The organic binders and materials like sawdust burn out, leaving voids in the sand into which the expansion can take place. The clays contract on dehydration, whilst the cereal binders dehydrate and burn out. The use of pitch increases the plasticity of the sand which allows greater deformation.

Scab conditions occur prior to the metal coming into contact with the sand. Therefore running methods that permit excessive or prolonged radiation of heat to the mould walls should be avoided. High pouring temperature and slow teeming should also be avoided.

Other Defects

Certain other defects such as cracking, short-runs, crushing and non-metallic inclusions have not been discussed here, but they can usually be avoided by the intelligent application of well-known foundry and metallurgical principles.

Pakistan Steelworks Project

Plans for the establishment of a Rs. 600,000,000 (nearly £65,000,000) iron and steel works have been completed by the Pakistan Industrial Development Corporation. The project will probably be financed in part by a loan from the World Bank, while foreign private enterprise will also be invited to participate. Tenders are expected to be invited in the first week of April for the import of mining equipment and plant for a steelworks with a capacity of 100,000 tons a year.

The works will be based largely on the designs and recommendations of Krupp's, the German concern, which has been acting as consultant to the corporation. The newly discovered Daudkhel deposits should be able to provide 250,000 tons of quality iron ore a year, and it has been recommended that natural gas be used as fuel, both directly and in the form of electricity.

BTC Orders for Rail Wagons

Contracts for 207 new coaching vehicles and 670 ballast and sleeper wagons have been placed by the British Transport Commission. Seven companies share the orders.

Forty gangwayed brake vans will be supplied by Cravens, Limited; Metropolitan-Cammell Carriage & Wagon Company, Limited, has an order for 95 corridor composite coaches, while Charles Roberts & Company, Limited, will provide 12 and the Gloucester Railway Carriage & Wagon Company, Limited, 60 corridor third brake vehicles.

The Gloucester company has also received a contract for 202 vehicles of the ballast and sleeper wagon order. The Butterley Company, Limited, will supply 252, Cambrian Wagon & Engineering Company, Limited, 116, and the Derbyshire Carriage & Wagon Company, Limited, 100.

Low Level of Unemployment

On February 14 there were 282,000 workers registered as unemployed, which was the lowest February figure recorded since the war, and represented only 1.3 per cent. of the total number of employees. Last month's total was 16,000 less than in the previous month and 105,000 less than in February of last year. Of the 282,000, only 113,000 had been unemployed for more than eight weeks. On February 9 there were 352,000 unfilled vacancies, 14,000 more than in mid-December, 1954, and 94,000 higher than in February of last year.

During January, employment in the basic industries increased by 9,000 and in manufacturing industry by 35,000. The engineering and metal goods group gained 19,000 workers during the month, and the vehicle manufacturers 9,000. There was also a rise of 3,000 in the number of wage-earners on colliery books.

Select Committee on Nationalized Industries

In accordance with the undertaking which it gave last July, the Government has tabled a motion in the House of Commons to set up a Select Committee on the nationalized industries. The committee will not interfere in the management of the industries, but its function will be to keep Parliament better informed about their activities and problems.

The 13 members proposed by the Government as members of the Select Committee are Lord Hinchingbrooke, Sir Ian Horobin, Miss Florence Horsbrugh, Mr. James Hutchison, Mr. Ramsden, and Sir Patrick Spens (Conservatives); Mr. Renton (National Liberal and Conservative); Mr. Albu, Mr. Ernest Davies, Mr. Noel-Baker, Mr. Palmer, and Mr. George Strauss (Labour); and Mr. Wade (Liberal).

Denationalization of Steel

In terms of employment and steel production, and sales, the disposal operation carried out up to September 30 last by the Iron and Steel Holding and Realization Agency represented about one third of the original publicly-owned sector of the industry. Since the end of the period—July 13, 1953, to September 30, 1954—for which the Agency's first annual report and accounts has been published, more recent sales have increased disposals of the Agency's inheritance to nearly three fifths.

On the appointed day—July 13, 1953—securities of 71 companies were vested directly in the Agency, and the companies were themselves the sole or majority holders of the capitals of 231 subsidiaries. On that day, therefore, 302 companies became subsidiaries to the Agency, which was established under the Iron and Steel Act, 1953, with the duty of returning to private ownership the iron and steel undertakings which it took over from the former Iron and Steel Corporation of Great Britain.

Gross Realization Proceeds

By September last 13 companies and their 126 subsidiaries—139 out of the original total of 302 companies—had ceased to be subsidiaries of the Agency, through the sale of the Agency's controlling interest. Gross realization proceeds from these 13 companies have so far amounted to nearly £78,000,000. Of that amount nearly £68,600,000 came from the sale of securities and some £9,400,000 from the redemption of securities and the cancellation of debt before sale. The Agency retained £14,900,000 for investment and other purposes, and the net amount paid over to the Treasury on capital account was £63,100,000.

Seven of the 13 companies were entirely sold. They had a book value to the Agency of £13,400,000. The gross proceeds were £15,000,000 (included in the total amount), giving an excess over book value on realization of £1,600,000.

The securities of the Lancashire Steel Corporation, Limited, were sold by public offer, the remainder by private sale. Three of the undertakings—Arthur Lee & Sons (Hot Rolling Mills), Limited, the District Iron & Steel Company, Limited, and the Templeborough Rolling Mills, Limited—were reacquired by their former parent companies. In the other six disposal operations, the Agency sold the equity capital only, and holds the prior charge capital for subsequent disposal. In these cases, the ordinary shares of Stewarts and Lloyds, Limited, and of the United Steel Companies, Limited, were sold by public offer. The ordinary shares of the other companies were disposed of by private sale to their former parent companies.

The disposals in respect of Guest Keen & Nettlefolds (South Wales), Limited, and Guest Keen Iron & Steel Company, Limited (formerly Guest Keen Baldwins Iron & Steel Company, Limited) were effected by a single sale.

The book value to the Agency of these six companies was £88,500,000, to which must be added £4,800,000 for additional investment in them by the Agency, and a further £2,800,000, being an adjustment arising from the elimination of an inter-company holding of shares in Guest Keen Baldwins Iron & Steel Company, Limited.

The gross proceeds from the partial disposal of the companies amounted to £63,000,000, and the adjusted book value to the Agency of the prior charges retained was £33,100,000. A comparison of proceeds with "cost" will not be possible, however, until the prior charges have been sold.

International Nickel's Records

New records were established in 1954 by the International Nickel Company of Canada, Limited, for net earnings, deliveries of nickel and ore mined. Net earnings of the company and its subsidiaries were $65,295,186, in terms of US currency. After preferred dividends, these earnings were equivalent to $4.34 per share of common stock. They compare with $53,694,526, or $3.54 per common share, for 1953, and with $62,875,571, or $4.17 per share, in 1951, the previous peak year. Common dividends of $42,276,690, or $2.90 per share, were paid, compared with $2.35 in 1953, and a previous peak of $2.60, in 1952 and 1951.

Deliveries of nickel attained a record total of 282,000,483 lb., an increase of 30,582,711 lb. over the 251,417,772 lb. delivered to the free world in 1953. For the first time in the company's history, more than 14,000,000 tons of ore were mined.

Exploration

Expenditures for exploration in 1954 were $5,255,462, compared with $6,084,742 in the previous year. Over the course of the past five years of capacity production, International Nickel added 72,834,149 tons to ore reserves, thus not only making up the 63,020,286 tons mined during the period but also providing a net addition of 9,813,863 tons. In the Mystery Lake area of Manitoba, the report states, the "company is investigating what may prove to be an important source of nickel-bearing ore adjacent to Moak Lake. Extensive surface drilling has been carried on, and, in order to obtain additional information on the nature of the deposit, as well as the underground conditions and geology of that area, a programme of underground exploration and drilling is being undertaken" at an estimated total cost of $2,000,000.

Oxygen Steel Plant in Canada

The Hamilton plant of Dofasco started up oxygen steelmaking in November last. The first of its kind in North America, the process is now in operation, with two more units planned in the immediate future. The furnace will produce 40 tons of high-grade steel per hour. Iron ore from Lake Superior, Labrador and Seven Islands, Quebec, is reduced in Dofasco's smelters and the molten iron delivered to the crucible of the new furnace in a ladle car. Here, 100 tons of 99.5 per cent. pure oxygen (Canadian Liquid Air Company's "Oxyton" process) can be delivered every day by recently completed plant and equipment. The principle on which the process works calls for directing a stream of high-purity oxygen on to the top surface of the bath. The vessel used is pear-shaped. In the case of a 40-ton vessel, the diameter is 14 to 15 ft. and the height about 25 ft. When charged with hot metal and scrap, the bath depth is about 3 ft. The specially designed water-cooled oxygen lance is suspended vertically in the centre line of the vessel with its end about 3 ft. above the bath.

Latest Foundry Statistics

According to the British Bureau of Non-Ferrous Metals Statistics, the output of copper-base castings during January was 5,174 tons as against 4,805 tons in January, 1954.

A NEW COMPANY, the Shallway International Corporation, Palo Alto, California, has been formed to promote the sales of shell-moulding and shell-core-making machines in Europe.

Nodular Cast Iron*

Present Position and Future Prospects as an Engineering Material, with Special Reference to Suitability for Crankshafts

London Discussion of the Paper by S. B. Bailey, M.Sc. (Eng.), M.I.Mech.E.†

[SLIGHTLY ABRIDGED]

(*Continued from page 270*)

A number of controversial points are taken up by the Author in this section of the discussion report. These include his reasons for the slow development alleged; amplification of the statement on the shortage of nickel; results from reversed-torsion fatigue tests; teething troubles; and nomenclature. Other properties reviewed by Mr. Bailey following the oral and written comment (previously recorded in these columns) include creep, shock resistance and notch effect. As to the part played by stress raisers in crankshaft design, the fact is deprecated that no direct comparison is available from the Motor Industry Research Association on forged v. *cast crankshafts of similar size.*

AUTHOR'S REPLIES

Slow Development

Mr. S. B. BAILEY wrote in reply to the discussion and comunications that he was very pleased to note that the Paper had aroused so much interest amongst engineers and metallurgists. He would like to thank all those who had added to the value of the Paper by their constructive criticism. The subject was a controversial one, and the Paper itself was incomplete without the discussion.

In reply to Dr. Angus, he had not intended to imply that the relatively slow development of nodular cast iron in Britain was entirely due to failures experienced. He would place the causes in order of importance as:

(1) The lack of incentive for British industry to take a risk in the commercial development of new engineering materials. Outside the aircraft industry, where the financial risks in research and development were borne by the State, British industry had for a long while been less receptive to new ideas than American industry. The latter had forged ahead with nodular cast iron because it could afford to pay for possible losses out of past profits.

(2) The high cost of the processes in use, which tended to make the end product expensive.

(3) Early failures of both single-treatment processes to produce a nodular structure when used with raw materials which were readily available.

(4) Failures of castings in transit or on test.

Nickel Price

Since the Paper had been written, his forecast of the continuing shortage of low-phosphorus pig-iron and nickel had proved accurate. Increased ore and freight charges had forced up the price of low-phosphorus pig-iron delivered in Birmingham from £16 14s. 6d. to £19 6s. 6d. per ton. Where nickel was concerned, it was as well to remember that the periods during which strategic metals were readily available to industry were not necessarily the same as the periods during which there was no declared war, so that the fact that Britain had had forty-four years of peace in the last fifty-four years meant very little. In peacetime, the prohibited uses of nickel had been prescribed by statute from June, 1951, until November, 1953, and, although the metal theoretically became freely available after the latter date, in practice the demand greatly exceeded the supply. He considered that he could not do better than quote the following remarks, which had appeared under the heading of "Nickel—Acute Scarcity of Supplies" in the *Metal Bulletin* dated Tuesday, September 7, 1954. (Since those remarks had been written, the official price of nickel had risen to £519 per ton):

> "The scarcity of nickel shows no signs of abating. Consumers are still clamouring for supplies and, for the limited quantities changing hands outside the producers' allocations, more than double the official price of £483 is being asked and obtained. Indeed, prices are often nowadays quoted per lb. and figures of ten shillings and higher are current. In the circumstances it is hardly surprising that much above the official raw nickel price is still being paid for scrap nickel."

New Caledonian nickel refined in Japan was fetching well over £1,000 per ton on the continent

* Paper presented to the Institution of Mechanical Engineers and printed in the JOURNAL, May 20, 27 and June 3, 1954. Other discussion contributions were printed in the JOURNAL, February 24, March 3 and March 10, 1955.

† The Author is on the staff of Intelligence Division, London Headquarters, Department of Scientific and Industrial Research.

of Europe. In those circumstances he did not consider there could be any justification for expecting large quantities of nickel to become available at a price which made it suitable for use in any economic process for making nodular cast iron.

Once it had been learned how to dispense with nickel in making nodular cast iron, the economics of the nodulizing process might present a very different picture. Payzanski (1954)* claimed that several heavy marine-engineering castings were being produced in a Kiev shipyard by a direct-magnesium addition process at a total cost of well below that of similar components in forged or cast steel. There was, of course, no means of substantiating that claim. The basic cupola as a means of making low-sulphur iron had only been quoted as an example of what might be done to reduce the production cost. If there were cheaper ways of making low-sulphur iron for batch production, presumably they would be used.

Reversed-torsion Fatigue

Whether the footnote dealing with Love's research erred on the side of caution or not would not be known until the reversed-torsion fatigue tests on nodular-cast-iron shafts had been carried out: as far as he knew, they had not yet been commenced. In the absence of any evidence to the contrary, the engineering designer would be well advised to be cautious, for no prizes would be awarded to the designer who incorporated a nodular-cast-iron crankshaft which subsequently proved too weak in reversed-torsion, and had to be replaced by a forged-steel shaft, with all the delay involved in making the necesary dies.

All his experience with crankshafts had been with steel shafts, and he was interested to hear Dr. Angus' opinion that most grey-cast-iron crankshafts failed in bending fatigue. That was really only to be expected, when their comparatively high torsional fatigue strength was borne in mind, and the inadequate support provided in many two-bearing, four-throw crankshaft engines which used them.

He was glad to hear that recent work at the British Cast Iron Research Association had tended to confirm the results of Saunders and Sinnott (1953) for the strength of nodular cast irons at high temperatures, and he looked forward to the early publication of some complete proof-stress/temperature curves for both pearlitic and ferritic materials. He would be very surprised if industrial and marine gas-turbine manufacturers (as well as the makers of aircraft gas-turbines) did not show a lively interest in nodular cast iron as a material for compressor stator casings.

He was sorry that Dr. Everest did not consider the Paper a very fair one, but the reason might perhaps be that he (the Author) had not attempted to "fall over backwards" to avoid making adverse comment where he had considered adverse comment to be necessary. It was his (the Author's) opinion that the majority of the technical papers which had been written on nodular cast iron had been written by people having some personal interest in the increased use of the material, either as inventors, licensors, or licensees of patented processes, or as technical sales representatives. Whilst such Papers served a useful purpose in making some of the properties and applications of new materials more widely known, they rarely included any information on the difficulties and disadvantages to be expected, and the prospective user would be wise if he read them with caution. If it was unfair to review the disadvantages as well as the advantages, then he agreed that he had been unfair. However, he had looked at the new material from the users' point of view, and perhaps he might be forgiven for having laid aside his rose-coloured spectacles.

Choice of Name

His choice of the word "nodular" had been made on three grounds. First, the Oxford Dictionary defined a nodule as "a small rounded lump of some mineral or earthly substance" and a spheroid as "a body approaching in shape to a sphere, especially one formed by the revolution of an ellipse about one of its axes." A glance at Fig. 3 would convince most engineers (who studied geometry in their curriculum) that "nodule" was the more accurate description of the lumps of graphite to be found in that iron.

Secondly, he abhorred abbreviations which could be misunderstood and long-winded names which were difficult to enunciate. "Spheroidal-graphite cast iron" was much more of a mouthful than "nodular cast iron," and if everyone understood what was meant by the latter description, he did not see why one should burden oneself with the former. "S.-g. iron" was not, in his opinion, acceptable, since the letters "S" and "G" formed part of the registered trade name of a British engineering company.

Thirdly, he believed that when a new material was invented, the name first used by the pioneer in that field ought to be adopted if there were no very good reasons to the contrary. Morrogh, working at the British Cast Iron Research Association, had been the pioneer, and he had called the material nodular cast iron. Millis, Gagnebin, and Pilling, who had come along with the magnesium process a year later, had chosen to call the material spheroidal-graphite cast iron. Whatever their reasons may have been, it was impossible to determine from the microstructure whether nodular cast iron had been made by the cerium process, or by the magnesium process, or by a combination of the two.

Of course, Dr. Everest was right when he said that the term "nodule" had been associated with the graphite structure in malleable cast iron: but the perpetuation of errors did no one any good. He had been careful to give what he considered was an accurate description of the graphite formation in blackheart malleable iron: he had described it as "an agglomeration of fine discrete particles." He had not shown a microstructure for whiteheart

* Payzanski, V., 1954, Morskoi i rechnos flot (Russian Shipbuilding and Ship Repair), vol. 14, No. 5, p. 22, "Use in Shipbuilding and Ship Repair of High Strength Cast Iron Containing Nodular Graphite."

malleable iron in the Paper as the structure was rather variable, but one which was by no means unusual would be produced, where the graphite was in the nodular form.

It was his opinion that the reason why metallurgists had once tended to call all graphite formations in malleable cast iron "nodules" was that early polishing techniques had removed all the graphite at the surface, and it had not been appreciated that the little craters left in blackheart malleable iron had not been filled by integrated nodules. With modern polishing techniques the true structure was revealed, and there was no excuse for calling the graphite formations, illustrated in Fig. 2, "nodules."

Creep Data

In regard to the publication of creep data on nodular cast iron, he presumed that Dr. Everest was referring to the paper presented by Stauffer (1953)* at the Fifth International Mechanical Engineering Congress in Turin in October, 1953. Dr. Everest appeared to have overlooked the fact that his (the Author's) Paper had been submitted to the Institution the preceding June, and that it had been January, 1954, when he had first seen Stauffer's Paper. Even had he been so fortunate as to attend the Congress in Turin, the data would still have been too late for inclusion. In order to remedy that, however, he had added the specific creep-stress curves in Fig. E. The data for the light alloys were taken from the sources given in Appendix III of the Paper; that for mild steel from some unpublished NPL data kindly supplied by Mr. R. W. Ridley, and that for nodular cast iron from the Paper by Stauffer. The creep data on nodular cast iron were still meagre, but he understood that some work which was now in progress, at the College of Aeronautics, Cranfield, and elsewhere, would supplement them before very long.

Shock Resistance

In regard to shock resistance, Dr. Everest appeared to have confused marine with naval applications. He had no doubt that the mercantile marine would make full use of nodular cast iron when the price was right, but he was a little doubtful about its application to fighting ships. Flake-graphite grey cast iron had at one time been acceptable for naval machinery, but (Bean, 1947)†

> "the damage sustained by HMS Belfast in 1940 due to an underwater explosion when a large proportion of her main and auxiliary machinery was put out of action by the failure of the cast-iron structures to withstand the shock sustained, completely altered the requirements for such structures. Instructions were immediately issued prohibiting the use of cast iron in the manufacture of main and auxiliary machinery for new construction."

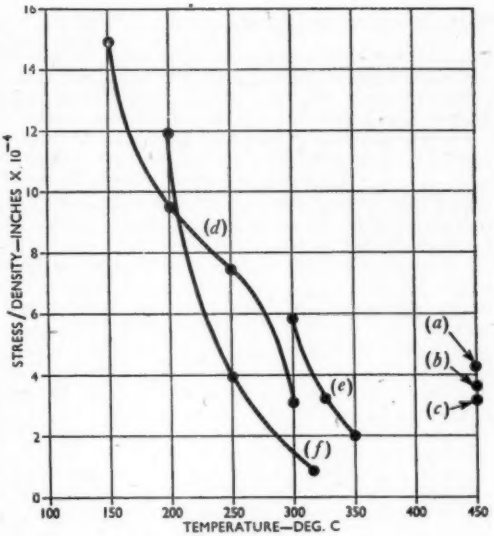


FIG. E.—*Curves showing variation of specific creep stress with temperature.*

Specific stress to give 0.1 per cent. creep strain in 500 hours. (*a*) Mild steel; (*b*) as-cast nodular cast iron; (*c*) annealed nodular cast iron; (*d*) RR.250; (*e*) ZT1.; and (*f*) ZRE1.

The instructions referred to had never been cancelled. He was aware of the United States Naval Research Establishment studies (Pellini, Sandoz and Bishop, 1954)‡ the results of which had been published since his own Paper had been written, but they had not caused him to change his views. The best of the nodular cast irons tested (heat 27, which contained 3.1 per cent carbon, 0.01 per cent. phosphorus, 0.19 per cent. manganese, 1.94 per cent. silicon, and 0.32 per cent. copper) had a Charpy V-notch impact resistance of 18 ft.-lb. at room temperature, falling to 6 ft.-lb. at −40 deg. C.: those figures compared rather badly with the values of 50 ft.-lb. and 18 ft.-lb., respectively, which were obtainable from a good nickel-free cast steel (see later and Fig. G). The conclusion of those authors from the results of their tests was that comparison with cast and rolled steels indicated that fully ferritic nodular irons of current commercial composition were less resistant to brittle fracture than the steels: in regard to properties at room temperature, that was an understatement.

The United States Military Specification MIL/I/17166/A (Ships) had been issued in April, 1952, which was before, not after, the publication of Pellini, Sandoz and Bishop's findings. It was true that it purported to cover ferritic-nodular-iron castings for applications where resistance to shock was required, but it was worthy of note that the only mechanical properties it specified were ultimate tensile strength, yield strength, elongation at fracture, and Brinell hardness. He did not think that

* Stauffer, W. 1953 *Proc.* Fifth International Mechanical Engineering Congress, Turin, "Some Applications of Spheroidal Graphite Cast Iron."

† Bean, C. W. C. 1947 "The Production of Naval Machinery from 1935 to 1945" (unpublished, written for the Engineer-in-Chief as contributory information for Professor P. M. Postan's book "British War Production" (Longmans Green, for HM Stationery Office, 1952)).

‡ Pellini, W. S., Sandoz, G., and Bishop, H. F., 1954, *Trans.* Am. Soc. Metals, vol. 46, p. 418, "Notch Ductility of Nodular Iron."

a specification for a shock-resisting material, which did not specify a minimum impact resistance at an agreed temperature, would find much favour with British engineers.

He had not stated either in the Paper or in his remarks when presenting the Paper that nodular-iron castings were not weldable. What he had stated was that ferritic nodular cast iron could not be welded without serious embrittlement, and it was his opinion that that was still true. That embrittlement might not show up in a slow tensile test, but under impact conditions at room temperature or under residual tensile stress in a fabricated structure at low atmospheric temperature, he would expect the weld metal to behave in a brittle manner. Whether welded nodular-cast-iron components were satisfactory or not depended entirely on the conditions in which they were to be used.

Notch Effect

Mr. Cox's explanation of the reason why flake-graphite cast irons had such a high ratio of torsional to bending fatigue strength seemed reasonable, but he did not see why it should be considered surprising that the notch effect in bending was so much more serious with nodular cast irons. If Mr. Cox's own hypothesis were used, and if it were assumed that the lumps of graphite approached to the shape of spheres, the theoretical stress-concentration factor for the round hole left at the surface would be three as compared with 10 for the jagged elongated hole left by the flake. The notches used in the cast-iron specimens in the reversed-bending-test results, quoted in Table II, had (Neuber, 1947) theoretical stress-concentration factors greater than three. One would expect such notches to have little effect in flake-graphite cast irons, but considerable effect in nodular cast irons. The fact that the notch effect in nodular irons was greater than Mr. Cox expected might very well be due to the nodule shape departing considerably from the true spheroid. He certainly agreed that the effects of size, and of fatigue under combined stresses, should be explored: he had been trying to interest people who had the necessary facilities in doing that, but so far without success. As indicated in the Paper, one company had kindly offered to carry out reversed torsion tests on nodular-cast-iron bars, but the necessary test-pieces or castings from which they could be machined had not yet been produced.

Teething Troubles

Upon reflection, he considered that Dr. Pearce was right when he suggested that he (the Author) had overstressed the teething troubles with nodular cast iron in the Paper. One tended to hear all about the failures and to take the successes for granted. To correct any wrong impression, he had altered the wording in the final version of the Paper to read "*some* (instead of *many*) engineering firms and research organizations have lost confidence in nodular cast iron." The number was probably less than a dozen, which was a very small percentage of the number of present users, though it was not a small percentage of those who had tried the material when the Paper had been written.

He appreciated Dr. Pearce's point that highly-alloyed austenitic nodular cast irons were available, but he had purposely limited the Paper to the alloy contents which were normally to be found in engineering steels. None of the 150-odd steels, the mechanical properties of which had been used in plotting the various graphs included in the Paper, contained more than 3.7 per cent. nickel, and he had not thought it fair to include austenitic nodular cast irons for comparison with them.

Stress Raisers

Dr. Becker was correct in assuming that the low values of nominal fatigue strength for the crankshafts quoted in Table III were due to the effects of stress raisers. The stress quoted was in each instance the nominal stress in the crank web as calculated from the formula $f = 6M/bd^2$, which took no account of crankpin and journal overlap, fillet radius, etc. However, as would be seen from the table, the ratios of fillet radius to pin diameter and web thickness did not vary much from one specimen to another. The nominal fatigue strengths could be legitimately compared, except for the forged-steel specimens which were much smaller than the cast-iron specimens. It had always surprised him that the Motor Industry Research Association had not carried out at least one test on a forged-steel shaft of the same size as its standard cast shaft, though he was aware that the cost of making the necessary dies would be high. The results would give a basis of comparison unhampered by size effect.

He agreed that surface hardening could increase bending fatigue strength both on account of the increased tensile strength, which went with increased hardness, and of the residual compressive stress which was induced in the surface material. However, whenever there were induced compressive stresses, there had to be induced tensile stresses to balance them, and the latter could lead to trouble. He knew of at least one instance where a nodular-cast-iron crankshaft, induction-hardened on the crankpins and journals, had a lower fatigue-strength than a similar unhardened shaft. The difficulty with surface heat-treatment was knowing where to stop, without leaving the residual tensile stress in the wrong place.

(*To be continued*)

A DAILY MAIL illustrated publication "Atomics in the Service of Mankind" makes an attempt to explain the nature, developments and potentialities of atomics in everyday life—recording a picture of the effect of this great scientific development in health, home, industry, agriculture and transport. The publication, which contains an article on isotopes applied to castings in production, and their non-destructive testing, is edited by Dr. A. D. Merriman, G.C., O.B.E., and costs 2s. (from any newsagent).

New Equipment

Dust Collector

The advantages of a wet dust collector that requires neither pump-unit, spray nozzles, nor filter bed, obviously merit serious consideration by founders. One such collector, known as the "Air Tumbler,"* is shortly to be made available to the United Kingdom market for incorporation on dust-exhaust installations in this country. It is being manufactured under licence from America by Ventilating Equipment, Limited, of Union Road, New Mills, Stockport, and 22, Hans Road, London, S.W.3. It is claimed that the "Air Tumbler" has solved with perfect economy of design the twin problems of efficiency and dependability. As indicative of results, the cleaned air may be returned to the exhausted enclosure in a great variety of applications. Heating costs are thus reduced, draughts and other troubles arising from sub-atmospheric pressure within the building are eliminated

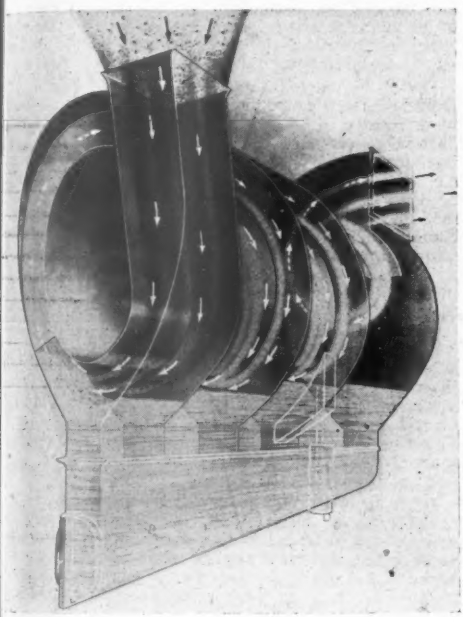


FIG. 1.—*The Air Tumbler Dust Suppressor.*

The "Air Tumbler" is a wet, dynamic dust-collector which separates the dust from the air by centrifugal action, while the water wets and entraps the dust. Fig. 1 shows its principle and the extreme simplicity of design—a stationary screw within a horizontal pear-shaped barrel. Beneath the screw is fitted the sludge tank filled with water into which the lower portion of each thread deeply extends. The dust-laden air enters at the inlet end of the unit and during its flow within the barrel the dust is continuously centrifuged through four revolutions along a helical path formed by the screw. The surface of the water is swept by the air stream, when the angular impingement together with the friction of the air against the surface of the water induces a sheet of water to flow around the periphery of the barrel.

The fact that the same water is re-used and that it travels in a continuous sheet against the inner surface of the barrel, never crossing or intermixing with the air stream, reduces the cooling and humidification of the air to a minimum, so that no condensation results during cold weather if the air is returned to the exhausted enclosure.

During its flow through the collector, the air is at no point compelled to reverse or abruptly change its course, or is its movement disturbed by baffles, narrow passages or other impediments like water sprays and eliminator plates.

Sludge Removal

The sludge may be removed batchwise from units requiring intermittent operation or continuously where constant operation is necessary. This collector is, therefore, available in a second type which will collect the coarser portion of the dry dust in a skimmer type pre-cleaner which forms an integral part of the unit, the dry dust being automatically released either by a simple form of trickle valve or by means of a motor-driven, rotary-valve discharging mechanism.

Simplicity is extended into details, as exemplified by the design of the water-level control. An overflow pipe prevents the water from rising above a predetermined level and a constant supply of water slightly in excess of the amount leaving the sludge tank prevents the water from falling below the open end of the overflow pipe. The excess water overflows into the air-seal tank and from there into a funnel to waste. As long as even a drop of water drips into the funnel the correct water level is assured—an arrangement which affords a visual check on the operation of the water-level control and eliminates the use of troublesome float valves or similar devices.

This unit is to be exhibited at the Engineering, Marine & Welding Exhibition and the Foundry Trades Exhibition in London later this year.

Pre-Coated Sand

Utilizing wet, local sands, Blackburn & Oliver, Limited, Wigan, Lancs, announce that, they have developed an entirely new process for the production of synthetic-resin pre-coated sand. This work was guided by two principles, *i.e.*:—(1) To enable foundries to produce a satisfactory pre-coated resin sand on their own premises, utilizing, to a large extent, existing machinery, and (2) to use cheap, local, wet sands, having the principal characteristics necessary for the shell-moulding process, instead of the more expensive special types of silica sand. The actual process is claimed to be a very simple one, demanding no skilled labour. The principle comprises the use of wet sand in conjunction with a special dry synthetic resin. Details of the process (British Patent application No. 2531/55) can be had by writing to the Research & Development Department of the firm at Lamberhead Industrial Estate.

Water Meters

A new range of water meters for pipelines has been developed by George Kent Limited, known as the "Master" range. It is made in 1¼-, 2-, 3- and 4-in. sizes (40, 50, 75, 100 mm.), and is a semi-positive rotary-piston meter which embodies many improvements from recent research and experience gained from over a million rotary-piston meters in service throughout the world. The 1¼-, 2- and 3-in. sizes have a maximum counter registration of 10 million imperial gallons, while the 4-in. has a maximum of 100 million imperial gallons. Meters can be calibrated in gallons, litres, cub. ft., or any other desired units.

* British Patent No. 629,292.

Iron and Steel Institute

Annual General Meeting

The eighty-sixth annual general meeting of the Iron and Steel Institute will be held on Wednesday and Thursday, April 27 and 28, at the offices of the Institute, 4, Grosvenor Gardens, London, S.W.1. A members' dinner (tickets £1 15s. 0d.) will be held at Grosvenor House, Park Lane, London, W.1, on April 27, at 7 p.m. Buffet luncheon (tickets 4s. 6d. per person) will be served in the library of the Institute, April 27.

Medals and Prizes

Bessemer Medal. The Bessemer gold medal for 1955 has been awarded to Professor John Chipman, head of the Department of Metallurgy, Massachusetts Institute of Technology, in recognition of his distinguished contributions to the knowledge of the physical chemistry of steelmaking.

Sir Robert Hadfield Medal. The Sir Robert Hadfield Medal for 1955 has been awarded to Mr. Tor Fjalar Holmberg, of Oy Vuoksenniska A.B., in appreciation of his meritorious service in improving the technique of the production of iron and steel at the Imatra Works, Finland.

Andrew Carnegie Silver Medal. An Andrew Carnegie Silver Medal for 1954 has been awarded to Mr. B. Cina for his paper on the "Effect of Cold Work on the Gamma-Alpha Transformation in Some Iron/Nickel/Chromium Alloys." (*Journal*, 1954, Vol. 177, August, pp. 406-422.)

Williams Prizes. Three Williams prizes of £100 each have been awarded for 1954, as follows: to W. Jackson for his paper on "Use of Cold Coke-oven-gas and Pitch-creosote Firing on Tilting Furnaces"; to R. McDonald for his paper on "Steelworks Waste-heat-boiler Practice"; and to A. Stirling for his paper on the "Pelletizing of Northampton Sand Ironstones by Vacuum Extrusion."

Programme

Wednesday, April 27, 9.45 a.m. to 4.30 p.m.—Morning and Afternoon Sessions.

9.45 to 10.30 a.m.—Formal business to include presentation of the report of Council and statement of accounts for 1954, and presentation of medals and prizes.

10.30 to 11.30 a.m.—Induction of the new president, Sir Charles Bruce-Gardner, Bt., and presidential address.

11.45 a.m. to 1.30 p.m.—Presentation and discussion of the following paper:—"The Gas Turbo-driven Blower for Blast-furnace Service," by C. E. Sayer.

1.30 to 2.30 p.m.—Buffet luncheon in the library.

2.30 to 4.30 p.m.—Presentation and joint discussion of the following papers, "Charging Delays due to Furnace Bunching," by R. Solt; "The Supply of Scrap to Open-hearth Furnaces," by M. D. J. Brisby and W. O. Pendray.

Thursday, April 28, 10.30 a.m. to 4.0 p.m.—Morning and Afternoon Sessions.

10.30 a.m. to 12.45 p.m.—Presentation and joint discussion of the following papers, "Causes of Variable Creep Strength in Carbon Steel," by W. E. Bardgett and M. G. Gemmill; "Creep and Rupture Data on Mo, Cr/Mo and Mo/V Steels," by J. Glen; "Statistical Study of Creep and Fatigue Properties of a Precision-cast High-temperature Alloy," by G. T. Harris and H. C. Child; "Relationships between Long- and Short-time Creep and Tensile Properties of a Commercial Alloy," by A. Graham and K. F. A. Walles.

(*Continued at foot of next column.*)

2.30 to 4.0 p.m.—Presentation and joint discussion of the folowing papers, "Mechanism of Accelerated Attack on Metals and Alloys by V_2O_5," by G Lucas, H. Weddle and A. Preece; "Effect of Composition of Gas-turbine Alloys on Resistance to Scaling and to V_2O_5 Attack," by G. T. Harris, H. C. Child and J. A. Kerr.

British Standards Information

The British Standards Institution *Information Sheet* for February lists under:—

New Standards Issued. 1121 Part 33: 1955 Methods for the analysis of iron and steel. Iron in ores, slags and refractories. 2s. 6d.—Describes a volumetric method applicable within a range of 0.05 to 100 per cent. iron, and an absorptiometric method applicable within a range of 0.01 to 1.0 per cent. iron. 1728 Part 6: 1955 Analysis of aluminium and aluminium alloys. Determination of iron (volumetric: titanous chloride method). 2s.—Specifies reagents required, recommended methods of sampling and test procedure. 1728 Part 7: 1955 Analysis of aluminium and aluminium alloys. Determination of zinc (zinc oxide method). 2s.—Specifies reagents required, recommended methods of sampling, and test procedure. 2580: 1955 Underground plug cocks for cold water services (Scottish type). 2s. 6d.—Gives requirements for material, manufacture, type of ends and main dimensions for plug cocks suitable for use underground on consumers' supply services from the water mains to control the supply of water. The plug cocks are operated by a key. Requirements for testing and marking are given.

Under "*Revised Standards Issued.*" 1326: 1955 Domestic electric washboilers. 3s.—Specifies minimum requirements for domestic electric washboilers having heating elements of the clamp-on or immersion type intended for use on voltages exceeding 30 volts r.m.s., a.c. or 50 volts d.c., but not exceeding 250 volts a.c. or d.c. It includes sections dealing with construction, materials, finish, marking, and information on tests, including rough-handling, stability, accessibility of live parts, performance and endurance.

Foremen and National Service

National Service was the principal cause of the dearth in industry to-day of young men who were willing to accept the responsible post of foreman, said Mr. Ian Garvie, chairman of the West of Scotland Association of Foremen Engineers, when he proposed the principal toast at the annual dinner of the Association in Glasgow on March 12.

When a young man got towards the end of his apprenticeship he lost interest. He knew the sergeant-major was standing at the door and that for two years while he was away he would be fed, clothed, housed, and even given pocket money. All he had to do was to do as he was told, and he would have no worries, anxieties, or responsibilities. Was it any wonder that when a young man returned to civilian life he shunned responsibilities? He looked for an easy job as a salesman or an insurance agent with a car at his disposal. He certainly did not want the worrying life of a foreman engineer. National Service might be necessary, and in some cases it might even be advantageous, but he felt that it was not producing the young man who would go into industry and accept responsibility.

Company News

PICKFORD, HOLLAND & COMPANY, LIMITED, manufacturers of refractories, of Sheffield—As from April 4 the assets and liabilities of the wholly-owned subsidiary, Webster & Company (Sheffield), Limited, are being transferred to the parent company. The subsidiary will then cease to trade under its present title and will be treated as a branch of the parent concern.

N. HINGLEY & SONS, LIMITED, ironmasters, of Netherton, Dudley (Worcs)—Treasury consent has been obtained for the proposed issue for cash of 200,000 10s. shares to stockholders on a one-for-four basis, which have now been priced at 40s. per share. The scrip issue of a further 200,000 10s. shares on a two-for-one basis will be made to those stockholders registered on March 28.

GLOVER & MAIN, LIMITED, gas engineers, of London, S.W.1—The company has acquired the whole of the share capital of Morley Products (Padiham), Limited. Mr. J. H. Morley will continue as its managing director and it is not intended that there will be any change in the organization of the company. Mr. P. D. M. Aird, deputy chairman of Glover & Main, will become chairman of the new subsidiary.

DELTA METAL COMPANY, LIMITED—A final dividend of 10 per cent., tax free, is announced for 1954 on the £1,500,000 one-class capital, as increased by a one-for-two free scrip issue. This follows an interim of 7½ per cent., tax free, on the former capital of £1,000,000. For each of the two previous years the total distribution was 20 per cent., tax free, comprising dividend of 12½ per cent. and a bonus of 7½ per cent.

MILLSPAUGH, LIMITED, papermaking-machinery manufacturers, of Sheffield—Preliminary accounts for the first quarter of the current year are most encouraging, says Mr. R. C. Heys, acting chairman, and profits for the full year to the end of September, 1955, should at least equal those of 1952-53. In his statement, Mr. Heys says the Canadian subsidiaries are being reorganized gradually to replace foundry by engineering sales.

MATHER & PLATT, LIMITED—The company's improved group trading profits for 1954 resulted from a satisfactory increase in the volume of business, the chairman, Mr. L. E. Mather, reports. The lack of skilled engineering labour limits the full exploitation of the firm's resources and causes delays in execution of contracts. This and raw-material shortages affect the competitive overseas business. Mr. Mather adds, however, that 1955 prospects are good.

SWAN, HUNTER, & WIGHAM RICHARDSON, LIMITED—The directors recommend a final dividend of 10 per cent. on the £3,422,128 ordinary capital as doubled by the free scrip issue last July. This makes, with the interim dividend of 4 per cent. on the former capital, an equivalent total of 12 per cent. on the present equity, or 2 per cent. more than for 1953 when 20 per cent. was paid on half the current capital. Group profits, subject to audit, have risen from £1,102,956 to £1,258,879, after tax of £1,466,702, against £1,081,912.

FORD MOTOR COMPANY, LIMITED—Further expansion was made by the company in 1954, when sales increased by £21,400,000, and the annual dividend raised by 3 per cent. The final dividend recommendation is 10 per cent. to make 15 per cent. for 1954 on the ordinary capital of £19,512,124. The 5 per cent. interim was the first paid since 1941. Stockholders received 12 per cent. for 1953, in which year Briggs Motor Bodies, Limited, was acquired. Group profits, after all charges, amount to £9,892,654 and compare with £5,527,302 for 1953.

NEWTON CHAMBERS & COMPANY, LIMITED—The directors recommend a final dividend of 9 per cent. to make a 15 per cent. total on a one-class reorganized capital of £2,000,000 for 1954. A year ago 30 per cent. was paid on £653,000 ordinary and £146,960 participating preference capital. The preference shares were converted into ordinary, making £800,000, and raised to the present total by a 150 per cent. scrip issue. The distribution requires £165,000 against £132,000 for 1953. Group profits expanded from £726,057 in 1953 to £768,015 and the net profit from £163,290 to £317,738.

BRUCE PEEBLES & COMPANY, LIMITED, manufacturing electrical engineers, of Edinburgh—When the year 1954 began, the company had cash of £200,000 and this has been increased to £428,365. These resources may be fully utilized in the near future, says the chairman, Sir William Darling. The company has many important contracts in progress as well as extensions to the works at East Pilton. Current assets have increased by £240,000 to £1,786,000, and current liabilities are higher at £761,408, against £684,282. Fixed assets have increased by some £20,000 to £331,534.

ASSOCIATED ELECTRICAL INDUSTRIES, LIMITED—During the year 1954 the group again attained a level of production exceeding in both value and volume all previous years. Although foreign competition has steadily risen, a substantial increase in export orders was obtained. The balance-sheet reflects the continued expansion of the group, with total net assets, representing the AEI stockholders' investment, up from £47,400,000 to £51,600,000. There are aggregate amounts of capital expenditure outstanding of £7,900,000, compared with £2,900,000 at December 31, 1953.

UK Trade in February

Exports from the United Kingdom in February are provisionally returned at £233,000,000. Since February is a short month it has been the practice to take the figures for January and February together. In the two months exports averaged £240,800,000, an increase of £27,000,000, or 13 per cent., over the corresponding period of 1954. Taking the five months October-February (this period includes last October's dock strike) exports are 2½ per cent. up.

Imports in February totalled £309,500,000, bringing the January/February average to £320,900,000. This was £59,000,000, or 23 per cent., more than in the same two months last year. In the period October, 1954, to February, 1955, imports averaged 12 per cent. more than in the corresponding period a year earlier.

Re-exports in February amounted to £9,000,000 and the January/February average to £9,600,000. The excess of imports, valued c.i.f., over exports and re-exports, valued f.o.b., was therefore at a rate of £70,000,000 a month in January/February (£73,400,000 in January and £67,500,000 in February), compared with £59,000,000 a month in the fourth quarter and £40,000,000 a month in January/February, 1954.

Exports to North America in February totalled £21,800,000. The average for January/February was £22,300,000 a month, 3½ per cent. more than in the same period of 1954. Exports to the United States in February amounted to £12,000,000, and for January/February they averaged £12,900,000 a month, over £1,500,000 a month (14 per cent.) more than in the corresponding two months a year ago. Exports to Canada improved to £9,600,000 in February, bringing the January/February average to £9,300,000 a month compared with £10,200,000 a month in the same period last year.

Plastics in Engineering

In the course of a paper on "Non-Metallic New Materials in Engineering," presented recently by Dr. N. J. L. Megson to the Institute of Marine Engineers in London, the author surveyed the plastics which have been developed in recent years and which find application in the production of structural components.

Particular attention was given in the paper to the glass fibre and asbestos reinforced plastics, which can be moulded at pressures much lower than those essential for conventional plastics. The materials used and methods of moulding were surveyed. Referring to the cost of plastics, the author said they were by no means cheap, and it might be necessary to pay anything from 4s. 6d. to 20s. per lb. for certain low-pressure materials. On the other hand, compared with metals, asbestos-resin mouldings have specific gravities between 1.0 and 1.7, depending on the moulding process used, so that one could use five times the thickness of plastic that might be employed for steel without increasing the overall weight. However, most of the plastic mouldings mentioned by him were so recent in their development that little could be said positively about their performance in service. It was probable, he said, that some would fail, but it was likely that others would fulfil their promise and that plastics would be used for an increasing number of applications where metals had hitherto held the field.

Quoting a table comparing the physical properties of a glass laminate with mild steel, it was shown that the specific gravity of the laminate was ½ that of steel; ultimate tensile stress lb. per sq. in., ¼; modulus of elasticity, $\frac{1}{10}$; cost per lb., nine times; and cost per cubic inch, double that of steel.

Changes of Name

Among the companies which have recently changed their names are those listed below. The new titles are given in parentheses.

MORSE CHAIN COMPANY, LIMITED, Works Road, Letchworth, Herts (Borg-Warner, Limited).

STORSHIP SALVAGE, LIMITED, 154, Bishopsgate, London, E.C.2 (Storhaven Engineering, Limited).

W. & G. (SURBITON), LIMITED, engineers, etc., of 29, Mincing Lane, London, E.C.3 (W & G (Storage), Limited).

TOWCESTER TOOL COMPANY, LIMITED, 27-34, Walnut Tree Walk, Lambeth North, London, S.E.11 (Churchill-Sturm, Limited).

TENUOUS STEEL COMPANY, LIMITED, Premier Works Wentworth Street, Sheffield, 5 (Tenuous Steel Investment Company, Limited).

VICENTOR, LIMITED, manufacturers of scientific instruments, etc., of Lyncroft Gardens, Ewell, Surrey (Newton Victor, Limited).

HINCHLIFFE (CONSTRUCTIONAL), LIMITED, engineers, etc., of 123, Victoria Street, Bristol (Harrison & Hinchliffe (Bristol), Limited).

EXCELDA (APPLIANCES), LIMITED, makers of electric soldering irons, etc., of 3, New College Parade, Finchley Road, London, N.W.3 (E. G. Kellond, Limited).

VANGUARD ENGINEERING COMPANY, LIMITED, mechanical and general engineers, etc., of Manfield House, 376, Strand, London, W.C.2. (J. W. Patterson, Limited).

DRAYTON REGULATOR COMPANY (HOLDINGS), LIMITED, Horton Lane, Yiewsley, West Drayton, Middlesex (Drayton Regulator & Instrument Company, Limited).

LANTERN BOXES, LIMITED, mechanical, electrical, and precision engineers, etc., of 35, Park Lane, South Harrow, Middlesex (Newton & Company, Limited).

A. & M. (WORCESTER), LIMITED, manufacturers of fluid-control, measuring, and treatment equipment, etc., of Bromyard Road, Worcester (Alley & Maclellan, Limited).

THOMAS CROMPTON & SONS, LIMITED, lock and hinge manufacturers, etc., of 41, Gerard Street, Ashton-in-Makerfield, Lancs (T. C. (Ashton-in-Makerfield), Limited).

GEORGE CLARK (1938), LIMITED, marine, mechanical, electrical, and general engineers, etc., of Northumberland Engine Works, Wallsend (George Clark (Sunderland), Limited).

NEWTON VICTOR, LIMITED (resolved to wind up voluntarily or special resolution dated December 31, 1954), scientific instrument makers, of 132, Long Acre, London, W.C.2 (Vicentor, Limited).

Industrial Development in India

Although the Government of India's first five-year plan does not end until the middle of 1956, consideration is already being given to the framing of the succeeding plan, the second five-year plan, in which, it is understood, greater emphasis will be placed on industrial development.

Because the State Governments do not command adequate technical facilities or possess sufficient resources of their own, it is expected that large-scale industrial developments in the public sector will be taken up by the Government of India, either directly or through the National Industrial Development Corporation. State Governments, however, were asked by the Central Government to submit proposals for inclusion in the second five-year plan. They include:—

Madras—Exploitation and utilization of South Arcot lignite and the setting up of iron and steel plant in Madras State and aluminium plant to utilize the Shevaroy bauxite.

Mysore—Expansion of the Mysore Iron and Steel works and the establishment of a ferro-manganese industry, a fertilizer industry, and an aluminium industry at Honnali or Harihar.

Hyderabad—Plant to supply town gas to Hyderabad and Secunderabad cities and a pilot power plant to utilize low-grade, high-ash content coals.

Rajasthan—Open-cast mining of lignite and the setting up of briquetting plant.

Punjab—Factories for the manufacture of tractors, electrical appliances, aluminium and lead.

Increases in Capital

STURTEVANT ENGINEERING COMPANY, LIMITED, London. R.C.A. increased by £500,000, in 5s. ordinary shares, beyond the registered capital of £500,000.

PLATT BROS. & COMPANY (HOLDINGS), LIMITED, Werneth, Oldham, increased by £289,840, in 6s. 8d. shares, beyond the registered capital of £3,710,160.

BEANS INDUSTRIES, LIMITED, engineers and ironfounders, etc., of Tipton (Staffs), increased by £600,000, in 5s. shares, beyond the registered capital of £510,000.

ROYCE ELECTRIC FURNACES, LIMITED, Walton-on-Thames (Surrey), increased by £20,000, in £1 ordinary shares, beyond the registered capital of £10,000.

BONE BROS., LIMITED, engineers, etc., of Alperton, Wembley (Middx), increased by £48,000, in £1 ordinary shares, beyond the registered capital of £2,000.

BRUCE PEEBLES & COMPANY, LIMITED, engineers, etc., of Edinburgh, increased by £250,000, in £1 ordinary shares, beyond the registered capital of £250,000.

CAPPER PASS & SON, LIMITED, tin smelters and refiners, etc., of Bristol, increased by £250,000, in £1 ordinary shares, beyond the registered capital of £1,750,000.

DAVEY, PAXMAN & COMPANY, LIMITED, engineers, etc., of Colchester, increased by £400,000, in £1 ordinary shares, beyond the registered capital of £1,000,000.

H. R. NOBLE, LIMITED, heating and ventilating engineers, etc., of London, N.13, increased by £10,000, in £1 unclassified shares, beyond the registered capital of £10,000.

R. E. A. AKERS & COMPANY, LIMITED, makers of gaskets and washers, of Birmingham, increased by £18,000, in £1 ordinary shares, beyond the registered capital of £2,000.

PICKFORD, HOLLAND & COMPANY, LIMITED, makers of refractories, etc., of Sheffield, increased by £200,000, in 5s. ordinary shares, beyond the registered capital of £200,000.

TILTMAN LANGLEY, LIMITED (formerly Tiltman Langley Laboratories, Limited), Redhill (Surrey), increased by £20,000, in £1 shares, beyond the registered capital of £30,000.

CHARLES RICKARDS & SONS, LIMITED, nut and bolt manufacturers, etc., of Darlaston (Staffs), increased by £300,000, in £1 ordinary shares, beyond the registered capital of £200,000.

JOSEPH SANKEY & SONS, LIMITED, makers of pressings and stampings, of Bilston (Staffs), increased by £1,000,000, in £1 ordinary shares, beyond the registered capital of £3,000,000.

BROWN LENOX & COMPANY, LIMITED, chain, cable, and anchor makers, etc., of Pontypridd (Glam), increased by £40,000, in £1 ordinary shares, beyond the registered capital of £60,000.

Imports and Exports of Iron and Steel in January

The following tables, based on Board of Trade returns, give figures of imports and exports of iron and steel in January. Figures for January, 1954, are included for the purpose of comparison.

Total Exports of Iron and Steel

Destination.	Month ended January 31.		Month ended January 31.	
	1954.	1955.	1954.	1955.
	Tons.	Tons.	£	£
Channel Islands	484	693	25,297	33,562
Cyprus	476	179	22,403	13,528
Sierra Leone	1,716	394	74,052	30,054
Gold Coast	3,970	1,883	210,298	82,898
Nigeria	4,482	4,280	304,580	278,414
Union of South Africa	3,974	9,939	310,202	533,788
Rhodesia and Nyasaland	2,881	2,342	159,796	148,624
Tanganyika	1,079	969	59,503	69,429
Kenya	5,358	3,753	295,912	176,469
Uganda	1,137	241	69,716	16,956
Mauritius	636	189	42,259	15,212
Bahrein, Qater, and Trucial Oman	2,730	547	156,113	40,452
Kuwait	1,187	272	64,102	24,032
India	7,436	9,955	513,937	637,830
Pakistan	4,921	5,774	387,756	315,850
Singapore	4,287	5,623	257,217	262,393
Malaya	1,781	1,351	114,051	91,534
Ceylon	1,100	1,836	69,633	112,383
British North Borneo	491	430	34,649	24,901
Hongkong	2,393	3,365	117,635	122,775
Australia	15,765	42,174	1,122,800	2,574,741
New Zealand	12,993	26,741	723,717	1,497,568
Canada	11,328	6,767	679,791	411,016
Jamaica	593	1,473	36,059	98,120
Trinidad	3,179	6,861	198,024	400,279
British Guiana	277	451	17,528	24,169
Anglo-Egyptian Sudan	3,416	1,760	172,765	95,820
Other Commonwealth countries	2,570	2,550	151,332	147,389
Eire	3,586	4,588	179,954	221,473
Finland	2,492	6,941	187,059	415,537
Sweden	6,714	14,538	359,867	638,860
Norway	9,002	10,269	484,080	456,982
Denmark	7,591	7,945	498,718	448,450
Western Germany	222	1,080	34,452	34,344
Netherlands	8,228	10,947	442,129	466,800
Belgium	804	1,158	77,763	76,275
France	535	578	61,858	57,461
Switzerland	635	1,292	66,376	122,077
Portugal	636	655	45,016	52,482
Spain	162	1,040	16,747	81,897
Italy	6,623	2,254	376,431	144,299
Austria	30	122	8,698	26,130
Yugoslavia	345	2,322	31,896	79,896
Turkey	801	952	29,059	68,194
Netherlands Antilles	263	545	18,304	26,547
Portuguese E. Africa	235	154	12,333	10,558
Lebanon	110	43	8,520	1,618
Israel	747	758	75,323	49,766
Egypt	2,110	3,213	95,896	157,094
Saudi Arabia	380	607	29,425	54,723
Iraq	1,859	1,100	102,727	70,444
Iran	127	3,992	8,061	148,166
Burma	539	1,371	33,057	87,894
Thailand	584	904	37,329	65,952
Indonesia	450	159	36,308	14,608
Philippine Republic	504	374	36,168	26,610
USA	2,513	5,835	322,989	340,421
Colombia	642	1,238	67,599	51,627
Venezuela	2,169	9,828	167,954	448,405
Ecuador	236	76	18,747	4,588
Peru	273	1,229	20,460	72,380
Chile	269	154	30,143	25,931
Uruguay	1,751	1,045	119,132	78,810
Argentina	3,518	4,611	256,484	375,522
Other foreign countries	3,668	5,589	273,384	361,183
TOTAL	173,993	252,298	11,061,573	14,144,590

THE RTSC GROUP has received Board of Trade approval for its plan to build a research laboratory at the Llanishen Industrial Estate, Cardiff. The laboratory and offices will take up an area of about 50,000 sq. ft.

Total Imports of Iron and Steel

From	Month ended January 31.		Month ended January 31.	
	1954.	1955.	1954.	1955.
	Tons.	Tons.	£	£
Australia	4,712	6	164,242	1,440
Canada	11	1,284	4,506	69,127
Other Commonwealth countries and Eire	932	295	49,285	28,258
Soviet Union	4,959	8,953	71,906	136,871
Sweden	1,800	1,925	184,214	207,547
Norway	2,230	5,297	149,926	367,355
Western Germany	3,748	800	133,385	90,478
Netherlands	9,307	8,562	357,001	332,626
Belgium	6,222	6,709	283,064	324,523
Luxembourg	2,642	1,391	85,809	65,791
France	8,959	5,471	235,076	327,904
Italy	29	33	12,881	3,823
Austria	37,712	2,536	762,504	55,371
Japan	—	665	—	67,662
USA	6,726	25,347	420,372	1,769,083
Other foreign countries	26	50	7,426	7,216
TOTAL	90,015	69,324	2,921,597	3,855,075
Iron and steel scrap and waste, fit only for the recovery of metal	68,161	104,064	1,144,144	1,694,038

Exports of Iron and Steel, by Product

Product.	Month ended January 31.		Month ended January 31.	
	1954.	1955.	1954.	1955.
	Tons.	Tons.	£	£
Pig-iron	480	5,107	9,926	84,237
Ferro-columbium (niobium)*	—	3	—	9,260
Ferro-tungsten	42	25	23,219	24,419
Other ferro-alloys†	256	166	198,525	49,367
Ingots, blooms billets, slabs, sheet and tinplate bars	1,008	743	59,649	32,269
Iron bars, rods, angles, shapes, and sections	230	477	12,097	20,992
Steel bars, rods, angles, sections, and shapes	19,668	40,053	1,124,573	1,807,316
Iron plates and sheets	310	8	22,081	502
Universal plates	891	678	35,071	23,732
Steel plates, ¼ in. and under ⅜ in.	481	1,352	41,264	69,920
Do. ⅜ in. and over	13,258	27,149	601,023	994,733
Black sheets and black plate	18,046	22,945	1,181,056	1,457,562
Hoop and strip	9,128	9,299	517,420	539,441
Tinplate	25,036	34,955	1,857,352	2,617,489
Tinned sheets, terneplate, and terne-sheets	194	251	20,650	21,412
Decorated tinplate	220	392	18,820	42,595
Galvanized sheets	12,304	13,554	884,185	1,005,088
Other coated plates and sheets	625	1,166	51,821	98,548
Railway and tramway construction material	17,317	18,817	777,458	814,214
Wire rods	2,680	2,857	81,537	95,063
Wire	4,839	10,836	340,720	666,486
Tubes, and fittings	44,651	59,516	3,046,399	3,541,298
Iron castings	1,698	1,466	59,261	52,766
Steel castings	190	163	38,996	32,834
Forgings	441	320	58,470	42,997
TOTAL	173,993	252,298	11,061,573	14,144,590

* Not separately distinguished before 1955.
† The figures for 1955 are not completely comparable with those for previous years.

Publications Received

British Bronze and Brass Ingot Manufacturers' Manual. Published by the British Bronze and Brass Ingot Manufacturers' Association; secretaries Heathcote and Coleman, 69, Harborne Road, Edgbaston, Birmingham 15; price 25s., post free.

This manual is very nicely presented. Its covers are in maroon plastic; it is spirally bound and for easy reference the various sections are divided by captioned protruding tabs. Section 1 modestly describes the advantages to be gained by the use of ingots instead of gypsied-up scrap. No mention is made of the fact that, using ingots, the smallest non-ferrous foundry can produce castings to tight specification limits. The next section is devoted to general metallurgical information. The data printed are alike reliable and well chosen, and cover the influence of impurities and the main alloys manufactured. The next 15 pages, or so, detail the main specifications of copper-base alloys—a useful inclusion. Section 4, written by Mr. Frank Hudson deals with " Melting and Running Methods for Copper-base Alloys," and the high reputation he holds guarantees not only authenticity, but also " readability." The next section covers the inspection of ingots, and such details as intelligent sampling and the like are dealt with. Section 7, contained in six pages, lists recommended alloys for diverse services, and following this is an index giving equivalent British standard specifications corresponding to a large number of other alloy designations, British and foreign. Indirectly, this serves as useful propaganda for limiting the number of specifications demanded from this industry. Finally, the manual is well indexed.

The Association has undoubtedly done an excellent service to the users of ingots by the publication of this book, and those concerned in its compilation deserve high praise.

Annual Report for 1954. Published by the International Tin Research Council, Fraser Road, Greenford, Middlesex.

This Report deals with the work of the Tin Research Institute and of the eight overseas branches. Dr. E. S. Hedges, who joined the staff in 1932 and has directed the researches since 1939, was appointed director of the Tin Research Institute; he is supported by two assistant directors, Dr. W. E. Hoare and Mr. W. R. Lewis.

Among the main subjects of research at the Institute's laboratories in Greenford, Middlesex, England, during the year were the newly perfected bearing alloys made of aluminium/tin alloy. These alloys can be used in massive form, but the main interest lies in bearings made from steel strip coated with a thin layer of aluminium/tin alloy; the difficulty of securing a strong bond between these two materials has been overcome. The laboratory tests indicate that even at loadings of 6,000 lb. per sq. in. these bearings have excellent running properties. Commercial development is under way in England.

Two electroplated alloys invented at the Institute are now coming into widespread use. Tin/zinc alloy electroplate is a matt finish for steel and its performance in marine conditions, as a protective coating, is well established. Details of this finish are now available in the Ministry of Supply's specification DTD 927. The tin/nickel alloy electroplate, on the other hand, is intended for all metals requiring a permanent brilliant finish. Both tin/zinc and tin/nickel electroplates are being widely adopted in industry.

" Organotin " compounds are being investigated for their possible applications in the preservation of wood, paper, textiles, etc., against fungi, moulds and insects. It is hoped that organotin compounds may be synthesized, which can be used for plant protection.

The activities of the Council's offices in Belgium, Canada, France, Germany, Holland, Italy, Sweden and the United States of America are each reviewed. The Report of the International Tin Research Council concludes with a list of the publications made during 1954. These cover all the main applications of tin; many of these publications are available on request, free of charge.

Non-ferrous Metal Industry in Europe. Published by the Organization for European Economic Co-operation—Paris 16. Obtainable in the UK from HM Stationery Office, P.O. Box 569, London, S.E.1.

This authoritative review, running to 150 pages, covers aluminium, copper, lead, zinc, nickel and tin. Each section is written by a recognized expert. Section IV captioned " Scope for Investment " does not refer to tips to investors, but as to whether the various metals do or do not require additional production facilities. All seem to be satisfactory except nickel which is still in short supply. The book proper (that is a survey of the situation in 1953 and the first half of 1954) finishes at page 53, and from there onwards are annexes, the first of which is statistical. Following this are detailed studies of each of the metals. As the metal market is always of major interest to non-ferrous founders, a study of this book must, *force majeure*, be of real help in determining buying policy.

Recruitment and Training of Men Intended for Management Positions. Published by the British Institute of Management, Management House, 8, Hill Street, London, W.1; price 5s.

If the executives of medium- and large-scale concerns are not already in possession of the information disclosed in this 70-page booklet, they should not be occupying positions of high responsibility. The booklet is the result of the work of a study group formed in October, 1953, but it is the reviewers' opinion that no new information has been disclosed.

House Organs

Albion Works Bulletin, vol. 9, No. 1, March 1955. Issued by John Harper and Company Limited, Willenhall, Staffs.

The following are abstracts taken from this very interesting house organ:—

A letter from an American customer reads " [Your castings] are more uniform and less troublesome than the average castings we obtain in the U.S.A." In connection with goggles it is stated that inadequate support was being accorded by most of the moulders to the management's efforts to supply the most suitable type. Each year this country manufactures £7 million worth of typewriters. A final note: the company is showing at the Cologne International Spring Fair.

Stainless Steel Review, vol. 1, No. 1. Published by British Electro Metallurgical Company, 103, Mount Street, London, W.1.

This first six-page issue is of an introductory character; it tells of the new wide-strip mill recently put into commission at Firth Vickers Stainless Steels, Limited, yet future issues, one would imagine, will take the form of the material appearing on pages 3 and 5 where uses of stainless steel in industry are shown.

News in Brief

PLANS for the modernization of the Austin & Pickersgill, Limited, shipyard at Southwick have received the approval of Sunderland Corporation.

A RECORD in factory-to-ship deliveries was made by Leyland Motors, Limited, last week, when over £250,000 worth of vehicles were exported.

AN IRON CRICKET BAT cast at the Trent ironworks in 1880 has been given to Scunthorpe museum. It carries the initials of W. H. Davis, who built the works.

ARGUS FOUNDRY, LIMITED, has had plans submitted for the proposed erection of a pattern store and extension of existing premises at Boydstone Road, Glasgow, S.W.3.

A FURTHER ORDER has been received by Head Wrightson Processes, Limited, from the Iraq Petroleum Company for air-cooled heat exchangers to cool Diesel engine jacket water.

S. MOLE & SONS (GREEN LANE FOUNDRY), LIMITED, is awaiting the approval of plans to proceed with the erection of foundry extensions in Bott Lane, Lye, Stourbridge, Worcs.

A MAJORITY INTEREST in Magnesium Elektron, Limited, previously a wholly-owned subsidiary of the Distillers Company, Limited, has been acquired by the British Aluminium Company, Limited.

ABOUT 10 ACRES of land in Neilson Road have been earmarked for proposed engineering works extensions by Clarke, Chapman & Company, Limited, boilermakers, marine engineers, etc., of Gateshead.

A LONDON OFFICE has been opened by the Wharton Crane & Hoist Company, Limited, Reddish, Stockport (Ches), at Lincoln Chambers, Portsmouth Street, W.C.2. The office is under the control of Mr. K. A. Bowman.

THE Federation of Light Metal Smelters announces that its members' average selling prices for the month of January have been calculated, to the nearest 10s., to be: LM1, £180 per ton; LM2, £183; LM4, £184 10s.; LM6, £187 10s.

FLETCHER BROS., textile machine builders, of Ilkeston, have purchased two acres of land at Hallam Fields to enable them to erect another factory. The new factory will be used in addition to their present works at Ilkeston.

MORE THAN £50,000,000 is to be spent by the South African Government on railways development in the financial year beginning April 1. The expenditure will include £29,000,000 for new works on open lines and £16,000,000 for rolling stock.

A CHART showing the movements of copper, tin, lead, and zinc prices in the 20 years ended 1954 has been prepared by Vivian, Younger & Bond, Limited. Copies are available on application to the company at 95, Gresham Street, London, E.C.2.

THE STEEL PLANT built by the Norwegian Government at Mo i Rana, a few miles south of the Arctic Circle, is to start production next month. The capacity of the plant—the first big integrated steelworks in Norway—is 170,000 tons of rolled-steel products a year.

THE 2,686 employees of Baker Perkins, Limited, engineers, Westwood Works, Peterborough, are sharing in £162,446 available under the employees' profit sharing scheme as additional remuneration for the financial year 1954. For the previous year, £162,675 was shared by 2,735 employees.

SALVAGE OPERATIONS are to be resumed by Metal Industries, Limited, on sunken German warships in Scapa Flow at the end of the month. The company has bought from the Admiralty the former German cruiser Karlsruhe, which is lying at the bottom of the Flow off the island of Cava.

SIR HAROLD WEST, managing director of Newton, Chambers & Company, Limited, Thorncliffe Works, near Sheffield, accepted on behalf of the works savings group the Parramore Savings Cup awarded by the Wortley Rural District local savings committee for best all-round progress during the year.

IN CONNECTION with the project of the New Zealand Government and the UK Atomic Energy Authority to produce heavy water and electric power from the steam of the hot springs in the Wairakei district of the North Island, the contract for the plant has been placed with Head Wrightson Processes, Limited, Thornaby-on-Tees.

SERIOUS CONSIDERATION would have to be given to moving part of the works elsewhere unless the additional 200 or 300 workers required could be obtained, said Mr. W. T. Freestone, deputy chairman, of Peter Brotherhood, Limited, the Peterborough engineers and ironfounders, at the annual dinner of the company's staff association.

WITH A CAPITAL of £100, International Combustion Group Purchasing, Limited, has been registered as a private company to carry on business as dealers in engineering materials, plant, machinery, etc. The directors, Mr. J. P. Gilliver, Mr. V. Young, and Mr. H. C. Short, are all directors of the International Combustion group and other companies.

A RESOLUTION will be considered on April 1 to change the name of the Electric Furnace Company, Limited, Weybridge (Surrey), to EFCO, Limited. The board plans to rearrange the subsidiaries so that the company will become virtually a holding company. Electronic Controls, Limited, would assume the name Electric Furnace Company, Limited.

THE STAMFORD WORKS of Blackstone & Company, Limited, have been visited by the Midland branch of the Institution of Highway Engineers to see the manufacture of large-scale Diesel engines and generators. They also saw the wide range of applications of small horse-power Diesel engines produced by R. A. Lister & Company, Limited, at the Dursley factory.

ON MARCH 16 Charles Roberts & Company, Limited, railway wagon builders, Horbury, Yorks, laid the foundation stone of a new office block, estimated to cost £30,000. The stone-laying ceremony was performed by Mr. Duncan Bailey, 79-year-old chairman of the company. It is hoped to open the extensions for use to celebrate the centenary of the company next year.

THE INSTITUTION OF PRODUCTIVE ENGINEERS announces that the 1954 George Bray Memorial Lecture, "Engineering and Production Aspects of Synthetic Fibre Manufacture," by Robert Douglas, M.B.E., M.I.PROD.E. (chairman, Dobson & Barlow, Limited, Bolton), will be delivered at the Reynolds Hall, the College of Technology, Sackville Street, Manchester, 1, on April 18.

AN EXHIBITION of Bakelite, Vybak, and Warerite plastics will be held at the Chamber of Commerce Assembly Hall, 95, New Street, Birmingham, from March 28 to April 2. The general public will be admitted free on April 1, from 3 to 8 p.m., and on April 2 from 10.30 a.m. to 5 p.m. Included amongst developments on show will be the shell-moulding method of making foundry moulds.

News in Brief

WOMEN were in the engineering industry to stay, Mr. R. Openshaw, president of the Amalgamated Engineering Union, said at the annual conference of the union's women delegates at Torquay recently. Management must cease to regard women as temporary hands and must reorganize not only their thinking but their factories to give women their rightful place beside the men in industrial life.

THE CAMBRIDGE INSTRUMENT COMPANY announces that on and after April 1 all enquiries for mercury-arc steel indicating and recording thermometers, vapour-pressure dial thermometers, automatic temperature regulators employing these systems, and pressure and vacuum dial gauges and recorders should be directed to their new "Mechanical Thermometer Division" at Friern Park, N. Finchley, London, N.12. Correspondence regarding all other types of Cambridge instruments should be directed, as hitherto, to the head office at 13, Grosvenor Place, London, S.W.1.

AS A RESULT of the acquisition, announced on March 18, of Vulcan Foundry, Limited, and its subsidiary, Robert Stephenson & Hawthorns, Limited, Darlington, by the English Electric Company, Limited, it is expected that the Darlington steam-locomotive building works will gradually transfer to electric and Diesel-electric engine construction in the next year or two. The Stephenson works at Newcastle has been supplying for some time units into which English Electric transmission equipment can be installed, and it is expected that the Darlington works will be used for a similar purpose.

THE ANNOUNCEMENT that Sir Winston Churchill is to receive the Charlemagne Prize during a forthcoming visit to Aachen is of interest to foundrymen. With some 600 students, Aachen technical high school has the largest metallurgical department of any similar institution in Western Germany, an outstanding feature being the foundry institute, established by the late Professor Piwowarsky. Damaged during the war, it has been rebuilt as a six-storey building training about 30 graduates a year for the foundry industry. Incidentally an institution analogous in scope and function to the British Cast Iron Research Association is being established at Düsseldorf.

SINCE THE END of 1954, further developments have been announced on two of the matters referred to the Monopolies Commission. First, the Commission has completed its report on the supply and export of various semi-manufactures of copper and copper-based alloys. Secondly, the Government has announced that it accepts the Commission's conclusions that the practices described in the Commission's report on the process of calico printing operate, and may be expected to operate, against the public interest, and that it is in general agreement with the Commission's recommendations. The industry has been so informed and discussions are to be held to discover the best way of carrying out the recommendations.

PACKED in three specially-built cases weighing 6 cwt. each, what is claimed to be the world's fastest camera, was despatched to New York on March 1. On receipt it will be examined by J. A. Maurer, Inc., of Long Island City, the makers' American agents, who will then deliver the camera to the United States Government, for whom it has been especially designed and made. The camera has been devised, developed and constructed by Winston Electronics, Limited, to enable photographs of one ten-millionth of a second exposure and at one half-millionth of a second intervals to be taken, six at a time. This is a frame-rate of two million per second—said to be at least 25 times as fast as any other photographic method.

MR. J. WILSON, principal of the Birmingham College of Technology, said, when he addressed members of the Birmingham branch of the Institution of Works Managers on March 8, that the United States had nothing to teach Britain about educational training for works management. He had come to this conclusion after a tour of the United States with an Anglo-American Productivity Council team during which he had visited 14 universities and nine industrial plants. America, Mr. Wilson said, had decided—wrongly in his opinion—to educate students for management positions without insisting first on practical experience within industry or commerce. He had been shocked, he said, to learn how little was being done in the educational field of management in Germany.

THE MEDICAL RESEARCH COUNCIL has arranged a residential conference to be held in Cambridge from March 31 to April 3. The conference will provide an opportunity for discussion of the latest results of research directed to improving the efficiency of the individual worker. Sir Geoffrey Vickers will take the chair and about 150 delegates from industry and research establishments are expected to attend. The subjects which will be discussed include the effects of environment on working capacity, the design of machinery in relation to the operator, the effects of continued or prolonged work on individual efficiency, industrial training problems, and the use which is made of research results. There will also be a short film, followed by a discussion, showing the way in which psychological processes and principles have relevance in daily life and industrial production.

KIDDERMINSTER PRODUCTIVITY COUNCIL is sponsoring a pioneer scheme which is an adaptation of the circuit visits suggested by the British Productivity Council. The Kidderminster scheme differs from the usual form in that specific subjects are chosen for study. A group of firms in the area agrees to sponsor a particular enquiry, and management representatives, members of the technical staff and shop-floor workers from each factory pay a series of visits to the factories of other firms. Terms of reference are agreed, and a set of guiding questions framed. The first problem to be investigated was the conservation of fuel, heat and energy, with 12 firms working in three groups. This enquiry was launched last summer and the report was made available in February of this year. The enquiry now in hand concerns personnel management and 16 firms are taking part. A third investigation is proposed into the methods of handling materials.

UNDER the auspices of FABRIMETAL and of the non-ferrous metal melters groups (FONOFER), a commission has been constituted, the aim of which is to promote the utilization of castings. The national Commission for the utilization of castings is endeavouring to solve the various technical problems with which engineers are faced, and to find out the basis of a better application of castings. As a first result of its activity, the Commission has decided to take part in the 7th Liége International Fair, which will be held from April 23 to May 8, and to have a stand which will show the recent progresses realized in the manufacture and the utilization of castings. An important congress, which will convene numerous Belgian and foreign lecturers will be held in the course of the Fair and the following main topics will be discussed: "Controls of Manufacture"; "The Foundry and its Customers"; and "The Foundry and Scientific Research."

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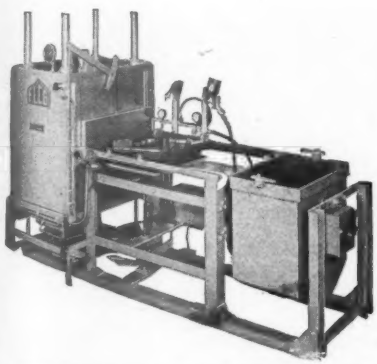

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Personal

Mr. TOM BROWN, managing director of Sheepbridge Engineering, Limited, is in Canada to visit the group's Ontario factory.

Mr. ALBERT CHATELET has been nominated a grand officer of the Legion of Honour, and Mr. JEAN RATY a Commander of the Order.

Mr. S. W. MARTIN, acting chairman and managing director of the Staveley Iron & Chemical Company, Limited, plans to visit Canada and the United States.

Mr. E. J. HUNTER, a director of Swan, Hunter & Wigham Richardson, Limited, the Tyneside shipbuilders, has been appointed a magistrate for Wallsend.

Mr. H. E. TURNER has been appointed service and home sales manager of the Parsons Engineering Company, Limited, Southampton. He has been with the company for more than 50 years.

COUNCILLOR G. P. ACHURCH, who has been a member of the Birmingham City Council for 14 years is not seeking re-election at the forthcoming elections. Managing director of Parker, Winder and Achurch, Limited, for 30 years until he resigned in 1950, he continues as chairman.

Mr. D. J. C. ROBERTSON has been appointed a director and production general manager of the Metropolitan-Cammell Carriage & Wagon Company. He succeeds the late Mr. N. HADDON. Mr. Robertson has also been appointed a director of Metropolitan-Cammell-Weymann.

Mr. E. L. BENNETT, of Harborne, Birmingham, deputy-chairman of the Harborne Ward Conservative Association, has been chosen as a candidate at the forthcoming elections for a seat on the Birmingham City Council. Mr. Bennett, who started on the factory floor when a boy, is now a director of an old-established firm of brass founders in the city.

Mr. W. W. WOOD, A.M.INST.C.E., M.I.E.E., has retired from the position of general manager of Pirelli-General Cable Works, Limited, which he has held since 1940, but remains a director of the company. He has been succeeded as general manager by Mr. J. R. HARDING, B.SC.(ENG.), M.I.E.E., hitherto the assistant general manager, who had previously occupied the position of manager of the overhead lines department.

ONE of the new members of the University Grants Committee appointed by the Chancellor of the Exchequer to serve until December 31, 1959, is Dr. WILLIS JACKSON, director of research and education of the Metropolitan-Vickers Electrical Company, Limited. Another new member is Prof. R. S. EDWARDS, who has been Professor of Economics, with special reference to industrial organization, in the University of London since 1949.

CAIUS COLLEGE, Cambridge, has awarded a fellowship to Sir EDWARD BULLARD, who is resigning his position as director of the National Physical Laboratory, Teddington, which he has held since 1950. Upon his return to the university, where he was Reader in experimental geophysics from 1945 to 1948, Sir Edward will undertake research into geophysics. His earlier research work was connected with atomic physics, and was done in the Cavendish Laboratory at Cambridge under Lord Rutherford.

Obituary

Mr. GEORGE RATCLIFFE, deputy service manager of Rolls-Royce, Limited (oil-engine division), Sinfin, Derby, has died at the age of 51.

Mr. GEORGE CLARK, O.B.E., J.P., former chairman and managing director of the Bryan Donkin Company, Limited, engineers, Chesterfield, died on March 11. He was an honorary freeman of the Borough of Chesterfield, and a former Mayor.

ON March 6, Mr. FRANCIS BARTLETT RICHARDS, a former chairman of Woodall-Duckham, Limited, died at the age of 70. He was a pupil of Lt.-Col. H. W. Woodall and in 1910 became assistant to Sir Arthur Duckham, with whom he was associated in the earliest stages in the development of the Woodall-Duckham continuous vertical retort. Mr. Richards retired from the chairmanship of Woodall-Duckham Construction Company, Limited, the principal operating company of the group, at the end of 1949.

Mr. FRANCIS G. CONNOR, managing director of the Metallurgical Equipment Export Company, Limited, London, S.W.1, died on February 28 at Caracas, in Venezuela. He was 55. A graduate of London University and of the City and Guilds Engineering College, Mr. Connor held the diploma of the Imperial College of Science and Technology. He joined the Electric Furnace Company, Limited, in 1928, and in 1945 was appointed managing director of the newly-formed Metallurgical Equipment Export Company, an organization co-ordinating certain export activities of a number of the leading British makers of heavy metallurgical equipment. He was also a director of Campbell, Gifford & Morton, Limited, consulting engineers, of Weybridge (Surrey).

THE DEATH has occurred at Sittingbourne, Kent, of Mr. Robert Archibald, managing director of the Planet Foundry Company, Limited, Guide Bridge, Manchester. He was 64 years of age, and had for many years worked for the Allied Ironfounders Group. He commenced his business career in 1907 with McDowall, Steven & Company, Limited, of Falkirk. He left there to join the staff of the Planet Ironfoundry Company, Limited, in 1922, was appointed a director and general manager of the company in 1936 and became managing director in 1952. Mr. Archibald was highly respected in the light iron castings industry and took a very prominent part in the activities of the British Ironfounders' Association and the British Bath Manufacturers' Association. He also represented the British Ironfounders' Association on the North West Regional Committee of the Coal Utilisation Council and was vice-chairman of the committee at the time of his death.

Mr. GEORGE WILLIAM BOOTH, managing director of Tyseley Metal Works, Limited, Birmingham, who died on March 16, 1955, aged 66, founded the firm 37 years ago. He some time later founded Mansill Booth & Company, manufacturers of brass pressings. For some years he had been a director also of James Bridge Copper Works, copper refiners, and T. C. Enstone & Sons, brassfounders. He travelled extensively before the war studying copper-refining methods abroad. These he applied to the plant at Tyseley. He was a member of the small committee from which the British Bronze and Brass Ingot Manufacturers' Association emerged and he served as president of this Association for three consecutive years, 1951-54. He had for many years been a member of the British Standards Institution, the Faraday Society and the Institute of Metals. He had a wide circle of friends at home and overseas, and his loss will be felt particularly in his native Midlands, where his business and charitable activities sealed the bond of friendship with so many.

FOR MELTING NON-FERROUS METALS

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Photographs show the use of crucibles by CARBORUNDUM in a tilting furnace. By courtesy of L. Gardner & Sons Ltd., Patricroft, Manchester.

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Raw Material Markets

Iron and Steel

During the past few weeks pig-iron production has been adversely affected by the severe weather, but that phase has now ended and blast-furnace outputs are back to normal. Important increases of output have recently been achieved by improvements in the preparation of materials, but imports of foreign iron will still be necessary until some of the new blast furnaces now building are brought into operation later in the year. In any event, these new furnaces will be devoted to the service of the steel plants, and foundrymen fear a continuance of their anxieties in regard to pig-iron supplies.

Production of low-phosphorus foundry iron for the manufacture of automobile and engineering castings is quite inadequate and foundries have resorted to the more extensive use of hematite. All available supplies of high-phosphorus iron are also absorbed and deliveries are barely adequate for present needs.

If there is any improvement in the deliveries of semi-finished steel to the light re-rolling mills it is so slight as to be almost imperceptible; nor has the arrival of consignments of billets from European ports entirely bridged the gap between supply and demand. Here, again, long-term plans for the expansion of supplies afford no immediate assistance and the re-rolling mills are carrying on under great difficulties. The heavy slabs principally used in the sheet trade are not so scarce, but the augmentation of deliveries of prime billets has become an urgent necessity. Scarcity of rods is also a limiting factor in the manufacture of wire products.

With ampler supplies of crude steel at their disposal, the rolling mills are turning out record tonnages of finished products. Steady progress has been achieved in the expansion of the output of sheets, plates, and all types of structural steel. But still demand outpaces the supply and bookings extend far into the second half of the year. There is certainly no abatement of the pressure for prompt deliveries, but it is noticeable that the rapid shrinkage of makers' stocks has been arrested and producers are providing more material for the expansion of the export trade, which remains a cardinal point in the nation's economic policy.

Substantial export provisions are obtainable in overseas markets, but these are offset by the high prices which have to be paid for imports from Europe and the United States.

Non-ferrous Metals

Copper staged a spectacular rise in value on the London market last week: cash increased by £15 10s., while three months closed £17 up, at £350 sellers. The backwardation was reduced to £10, the lowest for some time. The trend continued this week. At the close of the morning session on Tuesday cash metal was quoted at a new record level of £367 10s., but the afternoon brought some reaction.

Supplies are still difficult. Chile is virtually the only seller and even from that quarter there is little to be had for this half-year. The close on Friday was firm and there are signs of further advances, for the position in the United States suggests that an increase in the producers' price of 33 cents is imminent. The export price last week was quoted at 38 cents to 40 cents, f.a.s., an advance of 2 cents per lb., while on Friday the domestic quotation was listed at 33 cents to 40 cents. This is rather a wide spread and it is presumed that the Custom smelters have gone up to 40 cents.

Little change occurred in the other metals, zinc being unchanged for prompt at £89 10s. and up 10s. for forward, at £88. Lead closed £1 better in both positions, while cash tin gained £2 and three months 10s. The tin market lacks interest at present, but there are a number of uncertainties in the background at the moment which only time will resolve.

According to the figures issued by the British Bureau of Non-Ferrous Metal Statistics, January was quite a good month. Consumption of copper was 51,218 tons, compared with 53,496 tons in December, but stocks increased by nearly 1,300 tons to 62,771 tons in the form of refined copper. Stocks of zinc at the end of January were 48,027 tons, against 49,554 tons a month earlier, while usage, all forms, was 29,192 tons, which was practically unchanged from the December figure of 29,344 tons. In lead, stocks went up by 1,101 tons to 32,274 tons, while consumption, virgin and secondary, was 29,062 tons, about 220 tons up on December. Consumption of tin was 1,821 tons.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* March 17, £351 to £351 10s.; March 18, £359 to £360; March 21, £361 10s. to £362 10s.; March 22, £367 to £368; March 23, £359 to £360.

Three Months: March 17, £342 to £342 10s.; March 18, £350 to £351; March 21, £351 to £352; March 22, £357 10s. to £358 10s.; March 23, £349 to £350.

TIN, Standard—*Cash:* March 17, £714 10s. to £715; March 18, £715 to £715 10s.; March 21, £714 to £715; March 22, £713 10s. to £714; March 23, £711 to £712.

Three Months: March 17, £716 to £716 10s.; March 18, £716 10s. to £717; March 21, £715 10s. to £716; March 22, £715 to £716; March 23, £712 10s. to £713 10s.

LEAD—*Second half March:* March 17, £104 15s. to £105 5s.; March 18, £104 15s. to £105 5s.; March 21, £104 15s. to £105 5s.; March 22, £105 10s. to £105 15s.; March 23, £104 10s. to £104 15s.

Second half June: March 17, £103 15s. to £104; March 18, £104 to £104 5s.; March 21, £104 to £104 5s.; March 22, £104 7s. 6d. to £104 12s. 6d.; March 23, £103 5s. to £103 10s.

ZINC—*Second half March:* March 17, £89 5s. to £89 10s.; March 18, £89 5s. to £89 10s.; March 21, £89 5s. to £89 10s.; March 22, £89 to £89 5s.; March 23, £88 5s. to £88 12s. 6d.

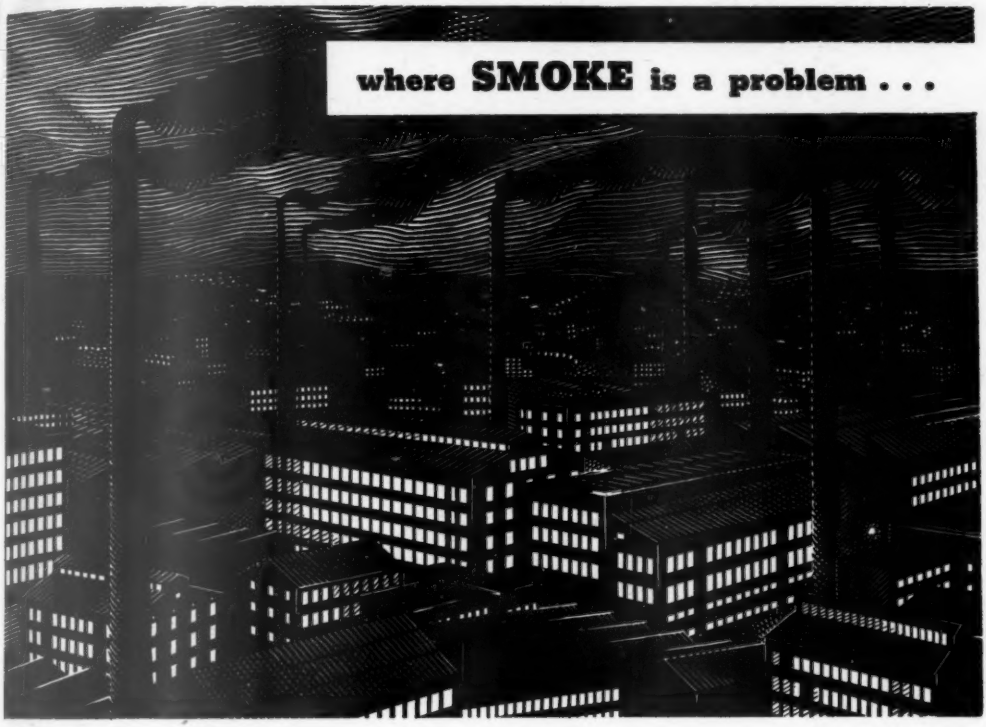
Second half June: March 17, £87 15s. to £88; March 18, £87 15s. to £88; March 21, £87 15s. to £88; March 22, £87 10s. to £87 15s.; March 23, £87 2s. 6d. to £87 5s.

Basic Materials Prices Rise

During February the prices of basic materials rose by 1.9 per cent. on January, mainly as a result of a further increase in the price of copper, which was, on average, 13 per cent. higher. Prices of tungsten ore went up by 19.4 per cent., tin ingots by 2.9 per cent., and zinc by 4.3 per cent.

In January the prices of basic materials had already risen by 2 per cent. on December—the largest increase for three years. Thus, the rise in prices in the first two months of this year had been almost as great as that for the whole of last year.

Index. It is regretted that there has been some delay in preparing the index for volume 97 of the FOUNDRY TRADE JOURNAL (July to December, 1954). Copies will be posted to regular recipients as soon as they are available and a notice will be printed in the JOURNAL at that time so that other readers may apply for copies they require.



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Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

March 23, 1955

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £15 12s. 0d.; Birmingham, £15 5s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £17 13s. 9d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £18 9s. 3d.

Scotch Iron.—No. 3 foundry, £18 2s. 3d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £20 4s. 0d.; South Zone, £20 6s. 6d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £21 1s. 6d.; South Zone, £21 4s. 0d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. of England (local iron), £18 2s. 6d.; Scotland (Scotch iron), £18 9s. 0d.; Sheffield, £19 7s. 6d.; Birmingham, £19 14s. 6d.; Wales (Welsh iron), £18 9s. 0d.

Basic Pig-iron.—£15 15s. 6d. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered)

Ferro-silicon (6-ton lots).—40/55 per cent., £40 15s. 0d., basis 45 per cent. Si, scale 15s. per unit; 70/84 per cent., £63 0s. 0d., basis 75 per cent. Si, scale 16s. per unit.

Ferro-vanadium.—50/60 per cent., 23s. 8d. to 25s. 0d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 11s. 0d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £161 0s. 0d. to £165 0s. 0d. per ton; 38/40 per cent., £258 0s. 0d. to £262 0s. 0d. per ton.

Ferro-tungsten.—80/85 per cent., 16s. 10d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 19s. 10d. per lb. of W.

Ferro-chrome (6-10 ton lots).—4/6 per cent. C, £78 0s. 0d. to £80 0s. 0d., basis 60 per cent. Cr, scale 25s. 0d. per unit; over 6 per cent. C, £76 0s. 0d. to £78 0s. 0d., basis 60 per cent. Cr, scale 24s. 0d. per unit; 2 per cent. C,* 1s. 8½d. per lb. Cr; 1 per cent. C,* 1s. 9d. per lb. Cr; 0.15 per cent. C,* 1s. 11d. to 2s. 1d. per lb. Cr; 0.10 per cent. C,* 1s. 11d. to 2s. 2d. per lb. Cr; 0.06 per cent. C,* 2s. 3d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 6s. 7¼d. to 7s. 1d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £225 0s. 0d. to £232 0s. 0d. per ton; 96/98 per cent., £259 0s. 0d. to £265 0s. 0d. per ton.

Ferro-columbium.—60/75 per cent., Nb + Ta, 52s. 6d. to 70s. 0d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £54 15s. 0d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £25 5s. 0d.; tested, 0.08 to 0.25 per cent. C, £26 5s. 0d.; hard (0.41 to 0.60 per cent. C), £27 10s. 0d.; silico-manganese, £34 10s. 0d.; free-cutting, £29 6s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £32 17s. 0d.; silico-manganese, £34 10s. 0d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £29 13s. 6d.; basic, hard, over 0.41 up to 0.60 per cent., C, £30 16s. 0d.; acid, up to 0.25 per cent. C, £33 15s. 0d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £31 1s. 6d.; boiler plates (N.-E. Coast), £33 11s. 6d.; floor plates (N.-E. Coast), £32 10s. 6d.; sectional material, N.-E. Coast, £29 4s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £31 19s. 6d.; flats, 5 in. wide and under, £31 19s. 6d.; hoop and strip, £33 1s. 6d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £34 5s. 0d.; black sheets (hand mill), 17/20 g., £43 13s. 6d.; galvanized corrugated sheets, 24 g., £55 4s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £54 7s. 9d.; nickel-chrome, £76 7s. 9d.; nickel-chrome-molybdenum, £86 8s. 6d.

NON-FERROUS METALS

Copper.—Cash, £359 0s. 0d. to £360 0s. 0d.; three months, £349 0s. 0d. to £350 0s. 0d.; settlement, £360 0s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 3s. 5½d. per lb.; rods, 401s. 9d. per cwt. basis; 20 s.w.g., 433s. 0d. per cwt.

Tin.—Cash, £711 0s. 0d. to £712 0s. 0d.; three months, £712 10s. 0d. to £713 10s. 0d.; settlement, £712 0s. 0d.

Lead (Refined Pig).—Second half March, £104 10s. 0d. to £104 15s. 0d.; second half June, £103 5s. 0d. to £103 10s. 0d.

Zinc.—Second half March, £88 5s. 0d. to £88 12s. 6d.; second half June, £87 2s. 6d. to £87 5s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £119 15s. 0d.; rolled zinc (boiler plates), all English destinations, £117 10s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £103 0s. 0d.

Brass Tubes, etc.—Solid-drawn tubes, 2s. 8½d. per lb.; rods, drawn, 3s. 6d.; sheets to 10 w.g., 347s. 3d. per cwt.; wire, 3s. 3⅛d.; rolled metal, 347s. 3d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £220; B6 (85/15), £305; BS249, £238.

Brass (High Tensile).—BS1400, HTB1 (30 tons), £261; HTB2 (38 tons), £273; HTB3 (48 tons), £283.

Gunmetal.—RCH, 3/4 per cent. tin, —; BS1400, LG2 (85/5/5/5), £291; LG3 (86/7/5/2), £302; G1 (88/10/2/½), £378; (88/10/2/1), £364.

Phosphor Bronze.—BS1400, PB1 (AID released), £393 per ton.

Phosphor Bronze Strip, etc.—Strip, 485s. 3d. per cwt.; sheets to 10 w.g., 508s. 9d. per cwt.; wire, 4s. 11½d. per lb.; rods, 4s. 4d.; tubes, 4s. 2½d.; chill cast bars: solids 4s. 3d., cored 4s. 4d. (CHARLES CLIFFORD, LIMITED.)

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 4s. 1½d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 6½d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 5½d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 3d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £109 0s. 0d. to £109 10s. 0d. Nickel, £519 0s. 0d. Aluminium, ingots, £163 0s. 0d.; aluminium bronze (BS1400), AB1, £337; AB2, £349. Solder, brazing, BS1845, 2s. 9d. lb.; granulated, 3s. 0d. lb.

* Average 68-70 per cent.